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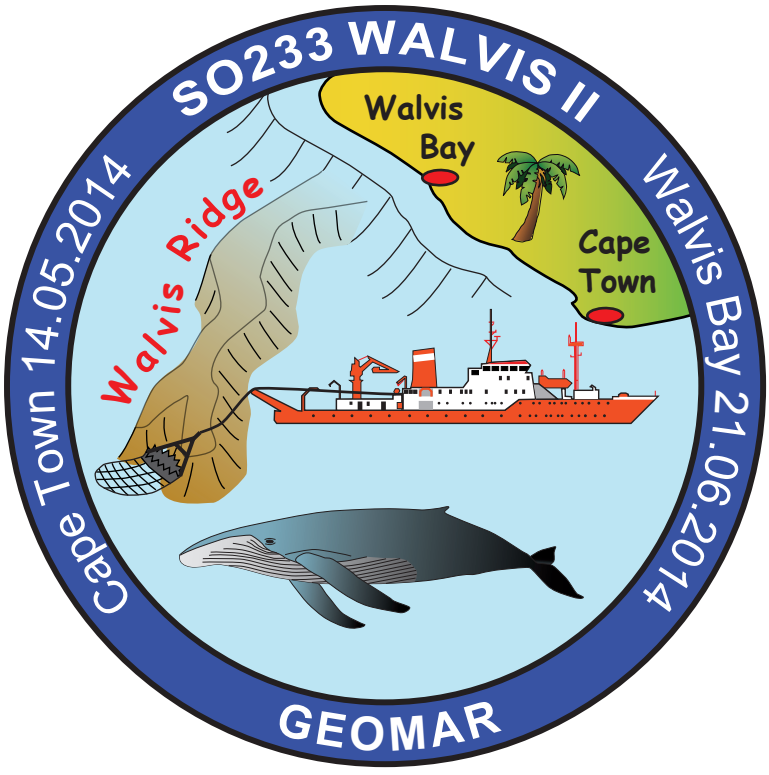
RV SONNE
Fahrtbericht / Cruise Report
SO233 WALVIS II

14.05-21.06.2014
Cape Town, South Africa - Walvis Bay, Namibia



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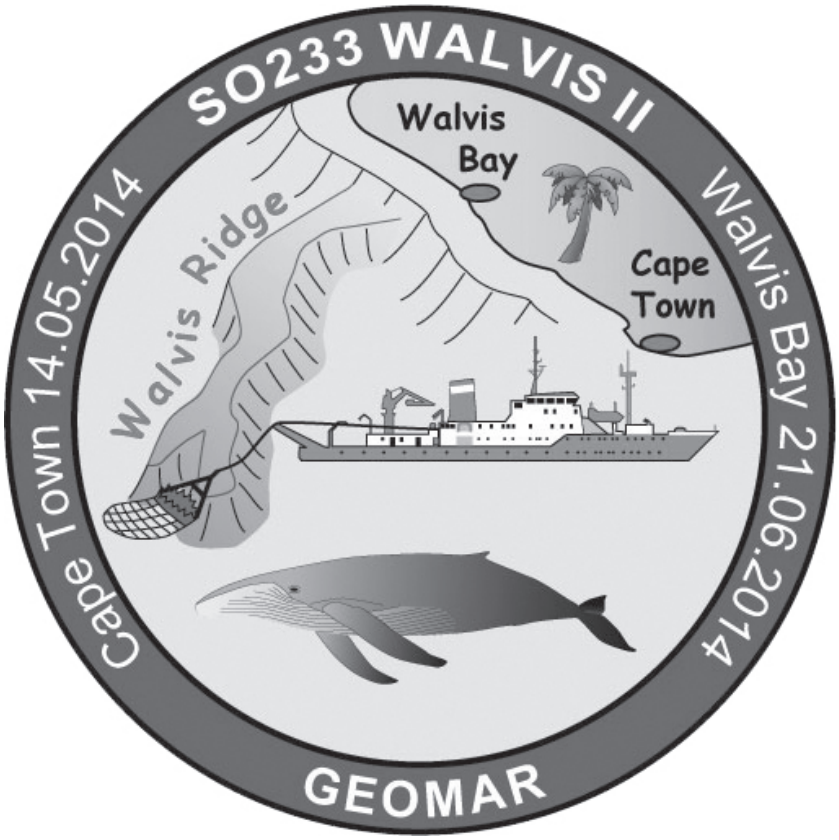

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SUMMARY

R/V SONNE cruise SO-233 WALVIS II conducted geological, morphological, and biological studies in the area of the aseismic Walvis Ridge and the adjacent ocean floor (South Atlantic). The Walvis Ridge is a textbook example of a hotspot track connected to a continental flood basalt province and represents the Atlantic “type locality” for the enriched mantle one (EM-I) geochemical endmember in intraplate volcanic rocks. Despite its importance in the global hotspot reference frame, endmember geochemical composition, and uncertainties in its formation and evolution, basement sampling of the Walvis Ridge remained poor to date, in particular along its easternmost 1500 km. The geological studies carried out during SO-233 therefore aimed for extensive multi-beam mapping using a SIMRAD EM 120 echo-sounding system, sediment echo-sounding using a ATLAS PARASOUND sub-bottom profiling system, and hard rock sampling by dredging and TV-grab of the Walvis Ridge and associated features. The major targets of the WALVIS II project are (1) to test for age progressive volcanism along the ridge, (2) to differentiate between classical hotspot and plate fracturing models for its formation, and (3) to constrain the origin, temporal and spatial evolution of melting conditions and source compositions (in particular regarding the EM-I endmember and proposed zonation models of mantle plumes). The biology program conducted on SO-233 comprised sampling of benthic organisms and meiofauna using a TV-multi-corer, a TV-grab, sediment traps installed in the geological dredges, and by collecting marine invertebrates from the hard rocks yielded by dredging. The biological investigations of the WALVIS II project intend to describe the benthic diversity of deep-sea invertebrates of the Walvis Ridge and will help to identify proxies of species connectivity and dispersal between the Walvis Ridge and neighboring ridge like structures (e.g. Agulhas Ridge). Another objective is to test whether connectivity of benthic communities in the Angola and Cape Basins is interrupted by the Walvis Ridge.

SO-233 multi-beam mapping revealed that the southern bifurcated section of the Walvis Ridge appears to have formed through the coalescence of former volcanic islands. The new bathymetric data also yielded several evidence for large-scale extensional tectonic movements which are most likely related to the separation of the Walvis Ridge and Rio Grande Rise that were rifted apart by the mid Atlantic Ridge. Seventy-one dredge hauls have been conducted during SO-233. Of these, 28 delivered massive lavas, 24 volcaniclastic rocks including breccias containing lava fragments, 22 sedimentary rocks, and 11 Mn-Fe-oxide crusts and nodules. The volcanic rocks comprise a broad variety of lavas as well as epiclastic, hydroclastic, and pyroclastic rocks. Carbonates dominate among the non-volcanic rocks, many of them represent relicts of fossil coral reefs. Despite technical problems with the EM 120 system and difficult weather and seafloor conditions occasionally constraining rock sampling, SO-233 achieved its major goals, i.e. bathymetric mapping and representative hard rock sampling of all major geomorphological units of the Walvis Ridge and of associated features. The set of rock samples recovered during SO-233 represents the by far most detailed sampling of the Walvis Ridge to date.

Out of 91 collecting stations, 80 stations yielded the total amount of 80 kg of sediment from sediment traps in the geological dredges, TV-multi-corer tubes and TV-grab. At 44 stations we could collect macrofaunal organisms, partly in large quantities. Ninety specimens of living brachiopods representing 6 genera were found at all depths and will mainly be used for molecular diversity studies. The remaining living macrofauna was largely composed of sponges, octocorals, some deep water hexacorals, molluscs, polychaetes, bryozoans, cirriped crustaceans and a few isopods and amphipods, mainly occurring in small numbers and medium diversity. The most spectacular finding was a fossil cold water reef mound community, which shows similarities in species composition to North Atlantic cold water reefs and proofs the influence of Antarctic benthos communities on the Walvis Ridge fauna mediated by northbound cold water currents. The samples represent the most diverse collection of benthos organisms ever retrieved from the Walvis Ridge region.

ZUSAMMENFASSUNG

Auf der FS SONNE-Reise SO-233 WALVIS II wurden umfangreiche geologische, morphologische und biologische Untersuchungen am aseismischen Walvisrücken und Strukturen auf dem benachbarten Ozeanboden im Südatlantik durchgeführt. Der Walvisrücken ist die atlantische Typlokalität des geochemisch angereicherten Mantelendgliedes EM-I und weltweit eine der wenigen Hotspotspuren, die mit kontinentalen Flutbasalten verbunden sind. Trotz der Wichtigkeit des Walvisrückens im globalen hotspot-basierten plattentektonischen Referenzsystems, seiner Bedeutung für das Verständnis geochemischer Mantelendglieder und offener Fragen bzgl. seiner Entstehung und Entwicklung war der magmatische Rücken, insbesondere in seinem ca. 1500 km langen östlichen Teil, bisher nur extrem lückenhaft beprobt. Die geologischen Untersuchungen im Rahmen von SO-233 umfassten daher umfangreiche Fächerecholotkartierungen (SIMRAD EM120), Sedimentecholotprofile (ATLAS PARASOUND) und Hartgesteinsbeprobungen mit Dredgen und TV-Greifer am Walvisrücken und assoziierten Strukturen. Die Hauptziele des WALVIS II Projektes sind (1) Überprüfung der räumlichen Altersprogression des Vulkanismus, (2) Unterscheidung zwischen klassischem Hotspot- oder Bruchzonen-Vulkanismus und (3) die Herkunft sowie zeitliche und räumliche Entwicklung von Schmelzbedingungen undMantelquellen, insbesondere des EM-I Endgliedes, und die Zonierung von Mantelplumes näher einzugrenzen. Das Biologieprogramm von SO-233 beinhaltete Beprobungen von marinen Benthos und Meiofauna mit einem TV-Multicorer, dem TV-Greifer, Sedimentfallen, die in den geologischen Dredgen installiert sind, und durch das Absammeln der Hartbodenfauna auf den gedredgten Gesteinen. Mit den biologischen Arbeiten im Rahmen von WALVIS II werden die Diversität benthischer Wirbelloser des Walvisrückens und deren Konnektivität zu vergleichbaren Lebensgemeinschaften in der Tiefsee angrenzender Ozeanbereiche (z.B. Agulhasrücken) untersucht. Gleichzeitig soll ermittelt werden inwieweit der Walvisrücken eine Ausbreitungsbarriere für Benthosorganismen des nördlichen Angola- bzw. des südlichen Kapbeckens darstellt.

Die bathymetrischen Kartierungen von SO-233 zeigen, dass der südliche, gabelförmige Bereich des Walvisrückens offenbar durch das Zusammenwachsen ehemaliger Inselvulkane entstanden ist. Die neuen Daten erbrachten auch mehrfache Beweise für eine großräumige Extensionstektonik in diesem Bereich des Südatlantiks, die höchstwahrscheinlich mit der Abtrennung des Rio Grande Rise vom Walvisrücken durch den mittelatlantischen Rücken im Zusammenhang steht. Insgesamt wurden 71 Dredgezüge während SO-233 durchgeführt. Davon erbrachten 28 massive Laven, 24 vulkaniklastische Gesteine (darunter Brekzien die Lavaklasten enthalten), 22 sedimentäre Gesteine, und 11 Mangankrusten und/oder -knollen. Die mit Dredgen gewonnen vulkanischen Gesteine umfassen ein breites Spektrum an Laven sowie epiklastische, hydroklastische und pyroklastische Gesteine. Unter den nicht-vulkanischen Gesteinen dominieren Karbonate, die häufig Relikte fossiler Korallenriffe repräsentieren. Trotz technischer Probleme mit dem EM120-System und stellenweise schwierigen Wetter- und Bodenbedingungen für die Gesteinsbeprobung hat SO-233 seine Hauptziele erreicht, dass heißt die bathymetrische Kartierung und repräsentative Hartgesteinsbeprobung aller wichtigen geomorphologischen Einheiten des Walvisrückens und assoziierter Strukturen. Der auf SO-233 gewonnene Gesteinsprobensatz repräsentiert die bisher bei weitem detaillierteste Beprobung des Walvisrückens.

Achtzig von insgesamt 91 Stationen erbrachten ca. 80 kg Sediment aus den Sedimentfallen in den Dredgen, den TV-Multicorer-Röhren und dem TV-Greifer für die Analyse der Meiofaunazusammensetzung. An 44 Stationen konnten Makrofauna-Organismen geborgen werden, zum Teil in sehr großer Anzahl. Neunzig lebende Brachiopoden aus 6 Gattungen werden hauptsächlich für molekulare Diversitätsstudien genutzt werden. Die übrige lebende Makrofauna setzte sich im wesentlichen aus Schwämmen, Oktokorallen, einigen Hexakorallen, Mollusken, Polychaeten, Bryozoen, Cirripediern und einigen Amphipoden und Isopoden zusammen. Der spektakulärste Fund war ein fossiles Kaltwasserriff, das in der Artenzusammensetzung Ähnlichkeiten zu rezenten Tiefwasserriffen des Nordatlantiks aufweist und deutliche Einflüsse der antarktischen Benthosgemeinschaften zeigt. Das Material repräsentiert die artenreichste Aufsammlung von Benthosorganismen des Walvisrückens, die bisher geborgen wurde.

1. ACKNOWLEDGEMENTS

We would especially like to thank Captain Meyer and the crew of the R/V SONNE. Their hard work, high level of experience, willingness to help, and the pleasant working atmosphere on board contributed significantly to the success of SO-233. In particular we were impressed by the efforts of the crew to maintain R/V Sonne and her facilities just two months before the vessel will be out of service.

We would also like to thank Helmut Kawohl (Kawohl Marinetechnik) for his support during the mobilization of the TV-multi corer during the port call in Cape Town and Asmus Petersen (GEOMAR) for helping to prepare the multi corer at GEOMAR. Dirk Nürnberg (GEOMAR, FB1) contributed to the success of the cruise by providing the multi corer incl. spare parts and by his consent to Florian Evers participation in the cruise.

We thank the Government of Namibia for granting permission to work within their territorial waters. We also gratefully acknowledge the support of the German Foreign Office and the German Embassy in Windhoek in this matter.

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2. PARTICIPANTS

2.1. Ship's Crew

Meyer, Oliver	Master	Guzman, Werner	Chief Engin.
Büchele, Heinz Ulrich	Chief Mate	Pieper, Carsten	2nd Engineer
Masemann, Hendrik	2nd Mate	Horsel, Roman	2nd Engineer
Aden, Nils	2nd Mate	Krawczak, Ryszard	Motorman
Borchert, Wolfgang	Head WTD	Thimm, Sebastian	Motorman
Meinecke, Stefan	WTD	Blohm, Volker	Fitter
Heuser, Sabine	Surgeon	Beyer, Thomas	Electrician
Wieden, Wilhelm	Chief Cook	Schmandke, Harry	Chief Steward
Garnitz, Andre	2nd Cook	Royo, Luis	2nd Steward
Schrapel, Andreas	Boatswain	Kuhn, Ben	Apprentice
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Golowin, Roman	Scientist	GEOMAR
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Mbidi, Inge	Scientist	Ministry of Mines a. Energy
Nauendorf, Alice	Scientist	GEOMAR/Museum für Naturk.
Portnyagin, Maxim	Senior Scientist	GEOMAR
Schwindrofska, Antje	Scientist	GEOMAR
Stiller, Björn	Student	RWTH Aachen
Werner, Reinhard	Senior Scientist	GEOMAR
Wind, Sandra	Student	CAU

The SO-233 Shipboard Scientific Party (photo: Wolfgang Borchert).

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3. MAJOR OBJECTIVES AND BACKGROUND OF SO-233 WALVIS II

(K. Hoernle, C. Lüter, R. Werner)

The Walvis Ridge (Fig. 3.1) is a textbook example of a hotspot track connected to continental flood basalts and represents the Atlantic “type locality” for the enriched mantle one (EMI) geochemical endmember in intraplate volcanic rocks. Despite its importance in the global hotspot reference frame, endmember geochemical composition and uncertainties regarding its formation and evolution, the Walvis Ridge has been poorly sampled, in particular along its central and northeastern end. Modern Ar/Ar age dating and a comprehensive geochemical data set (major and trace elements and Sr-Nd-Pb-Hf-O isotopes) of a detailed suite of igneous samples from the Walvis Ridge are needed (1) to test for age progressive volcanism along the ridge, (2) to differentiate between classical hotspot and plate fracturing models for its formation, and (3) to provide constraints on its origin and temporal and spatial evolution of source compositions (in particular the EMI endmember) and melting conditions and (4) to establish how far to the northeast along the Walvis Ridge the recently discovered geochemical zonation into two "Tristan" and "Gough" subtracks can be followed. Complementary studies include the geophysical cruise MSM17/1, 2 in 2010/2011, magnetotelluric studies to decipher form and structure of todays melt anomaly beneath Tristan Island (MSM20/2 in 2012), and in particular the petrological R/V MELVILLE MV1203 cruise by our U.S. partners (A. Koppers, C. Class, and W. Sager) during which the Guyot Province between the Walvis Ridge and Tristan and Gough Islands was mapped and sampled in 2012 (Fig. 3.1). The following section gives more detailed information on the scientific background of the SO-233 WALVIS II project.

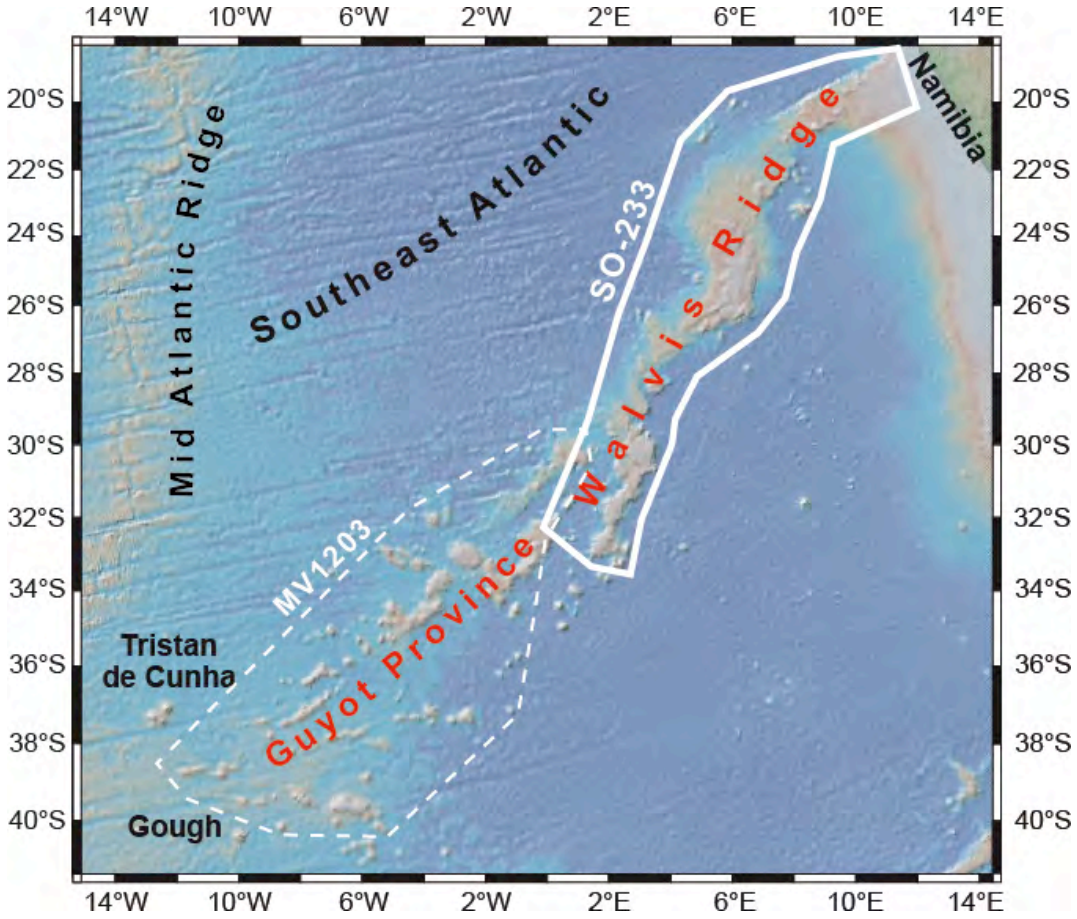

Fig. 3.1: Overview bathymetric map of the Tristan-Gough hotspot track extending from the volcanically active Tristan da Cunha and Gough island groups to the Namibian coast. The track comprises the aseismic Walvis Ridge and the Guyot Province to the southwest, comprising volcanic ridges and seamounts. Also shown are the working areas of R/V SONNE cruise SO-233 and the complementary R/V MELVILLE cruise MV1203. Source of base map is http://www.geomapapp.org.

3.1 THE HOTSPOT HYPOTHESIS

The hotspot or mantle plume hypothesis is the fundamental theory for explaining the origin of linear belts of intraplate volcanism on Earth. So-called hotspot tracks of volcanism can be best discerned on the seafloor, due to the thinner crust and lithosphere and more mafic and thus denser oceanic crust, making it possible for melts in the earth's upper mantle to reach the surface. In accordance with this hypothesis, age-progressive seamount chains and aseismic ridges on the seafloor are thought to reflect movement of the lithosphere over a stationary melting anomaly caused by buoyancy-driven cylindrical upwelling of deep mantle material such as mantle plumes (e.g. Wilson, 1963, Morgan, 1971; 1972; DePaolo and Manga 2003). Intraplate volcanism is also present on continental lithosphere, but due to the thicker and less dense crust, melts are facing more difficulties reaching the surface and therefore linear belts of volcanism are not as obvious. The connection of flood basalt provinces on continental margins linked to linear volcanic chains on the ocean floor has led to the plume head – plume tail model and to the hypothesis that plume heads can cause continental break-up (Richards et al. 1989; Richards 1991). In accordance with the starting plume head model, plume heads are associated with the initial stages of plumes and can reach dimensions of up to 2,000 km in diameter when they impact the base of the lithosphere, leading to widespread volcanism in relatively short-time periods (several million years) due to decompression melting of plume material. A narrow (100-300 km in diameter) plume tail follows the plume head and can exist for more than 100 Ma, generating melts that form age progressive volcanic chains.

Despite development of this hypothesis beginning in 1971, there is still some debate about the existence of mantle plumes, often termed the Great Plume Debate (e.g. www.mantleplumes.org). In more recent years, there has been a general acceptance of the hypothesis but at the same time an increasing recognition that much if not most intraplate volcanism is not related to hotspots. Therefore the debate now focuses on determining which intraplate volcanic systems, in particular ones with linear volcanic chains such as Tristan-Gough were formed by hotspots and which ones weren't. For the ones that weren't, the question becomes how were they formed. Questions related to hotspot systems focus on depth of origin, shape and fixity of mantle plumes, chemical zonation in mantle plumes and what this reflects, using spatial and temporal variations to map out mantle heterogeneity, more precise determination of age progressions of hotspot tracks in order to constrain better plate and plume (asthenospheric flow) motions, the morphology of hotspots and what this tells us about plume structure and changes in the direction of plate motions, etc. The so called "great plume debate" is, however, largely based on theoretical models, since only a few primary hotspot tracks have been sampled sufficiently to enable critical tests for the various models. Despite the recent challenges, the plume hypothesis will continue to play a key role in improving our understanding of solid earth cycles, mantle convection and plate motion. Nevertheless modifications are required, and given the various theoretical models mentioned above, it is now important to provide more rigid constraints on the temporal, morphological and geochemical evolution of intraplate volcanic systems.

3.2 WALVIS RIDGE IN CONTEXT OF THE TRISTAN-GOUGH HOTSPOT SYSTEM

The Walvis Track, the most prominent bathymetric feature on the African Plate in the South Atlantic, forms the NE portion of the ~3,300 km long volcanic chain on the seafloor stretching from the coasts of Namibia and Angola southwest to the volcanically active Tristan da Cunha and Gough Island groups (Figs. 3.1, 3.2). The Walvis Ridge has an average width of ~200 km and is ~1,900 km long. The Guyot Province, which widens to the southwest, consists of individual volcanic structures (seamounts, small ridges and islands) forming the „Tristan" (in the north) and „Gough" (in the south) sub tracks. The flat-topped guyot seamounts on the Walvis Ridge and in the Guyot Province provide evidence that some of these structures formed islands in the past. Both seamount chains (sub tracks) become more diffuse and discontinuous as they approach the volcanically active islands of Tristan da Cunha and Gough, thus implying a decrease of volcanism with time. Gough and the Tristan island groups are 400 km apart, indicating that - in contrast to the aseismic Walvis Ridge - the width of the Guyot Province cannot have formed over a 200 km wide, traditional plume-tail-type structure. On the South American plate, the Rio Grande Rise forms a less well-defined NW-SE trending

bathymetric anomaly that crudely connects with the Paraná continental flood basalt (CFB) province (Fig. 3.2). The somewhat isolated position of the Rio Grande Rise is thought to result from a Late Cretaceous (c. 60 Ma ago) westward migration of the Mid Atlantic Ridge, after which volcanism of the Tristan-Gough system was restricted to the African Plate (O'Connor and Duncan 1990; O'Connor and le Roex, 1992). In conclusion, there appears to have been a decrease in magma production from the Parana/Etendeka flood basalts, along the Walvis Ridge and Rio Grand Rise and then along the Guyot Province to Tristan da Cunha and Gough.

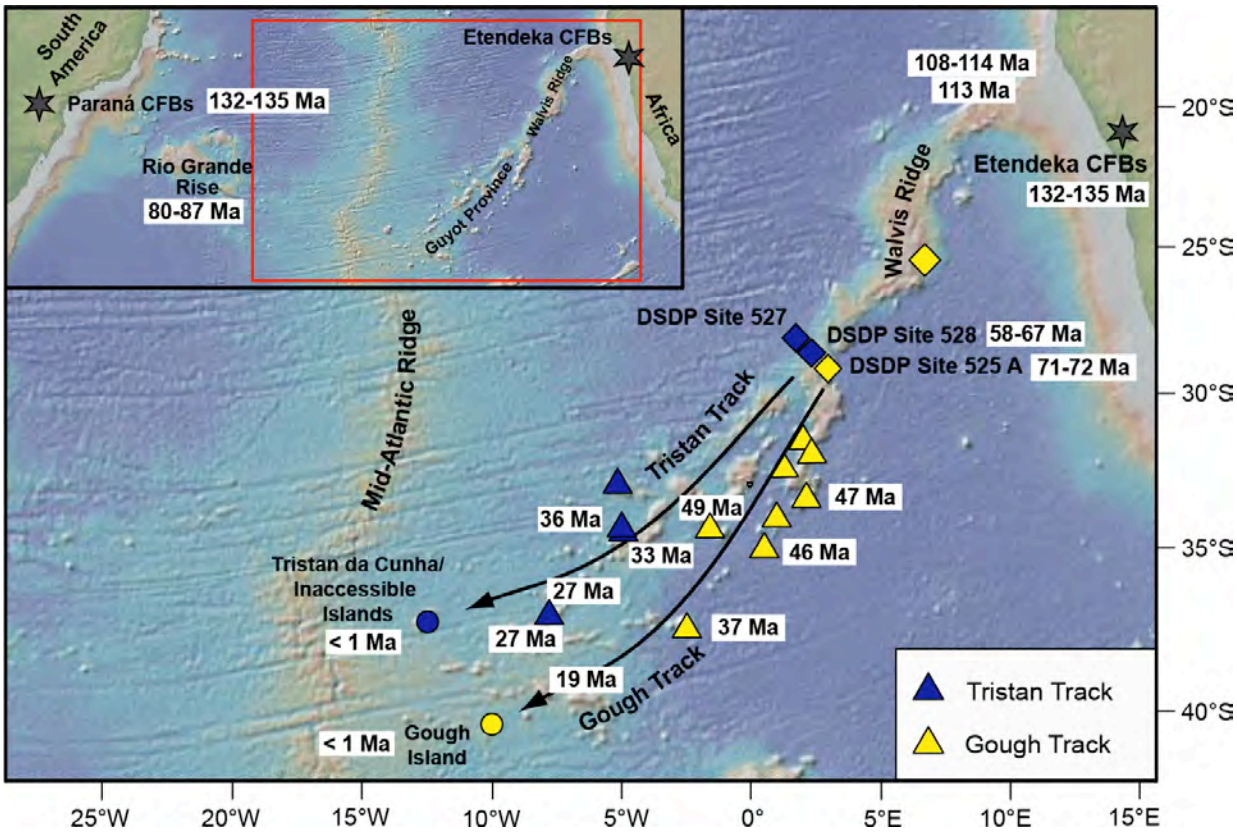

Fig. 3.2: Bathymetric overview map (modified after Rohde et al. 2013a) of Tristan-Gough hotspot track, showing Tristan and Gough subtracks. Symbol shapes denote sample locations from islands (circles), Guyot Province (triangles), and Walvis Ridge (diamonds), while symbol colors denote Gough (yellow) and Tristan (blue) geochemical domains. $^{40}Ar/^{39}Ar$ ages are from Rohde et al. (2013b, and references therein). Inset map shows locations of Paraná and Etendeka CFBs (gray stars) and Rio Grande Rise. Red box in inset designates area of main map figure. Source of base maps is http://www.geomapapp.org.

Models for the formation of the Walvis Ridge and Rio Grande Rise use either a classical Tristan-Gough hotspot model (e.g., O'Connor and Duncan, 1990; O'Connor and le Roex, 1992) or envision episodic fracturing of oceanic crust (Le Pichon and Hayes, 1971; Francheteau and Le Pichon, 1972; Fairhead and Wilson, 2005). The classical hotspot model links the magma source of the volcanically active islands of Tristan da Cunha and Gough to the formation of the Walvis Track and Rio Grande Rise during the opening of the South Atlantic. It also implies that the Etendeka and Paraná CFB's are the earliest expressions of the Tristan-Gough hotspot in the framework of a plume head - plume tail model (Richards et al., 1989). In this respect the fanning of the aseismic Walvis Ridge into the Tristan and Gough sub-tracks of the Guyot Province could in part be connected to the ca 60 Ma westward shift of the MAR which was presumably accompanied by northward migration of older lithosphere over the hotspot, changing melting conditions from on-axis to intraplate and possibly causing the melting anomaly to spread out (O'Connor and Duncan 1990; O'Connor and le Roex, 1992; Rohde et al., 2013a, b). Recent seismic tomographic studies provide evidence that low-velocity anomalies, in the form of cylindrical structures with diameters of 100-400 km, can extend to the core mantle boundary or at least into the lower mantle beneath the young ends

of many hotspot tracks, providing new support for the mantle plume hypothesis (Montelli et al. 2004, 2006). Such a low-velocity anomaly, however, has not yet been observed beneath Tristan da Cunha or Gough Islands, the youngest volcanic structures at the end of the Walvis Hotspot Track, possibly reflecting a weak and diffuse upwelling of a dying plume.

The alternative plate fracturing model for the Walvis Track formation favors a complex interplay of E-W transform fault segments and N-S segments formed by crustal modifications as a consequence of changing poles of rotations during the initial opening of the South Atlantic (Francheteau and Le Pichon, 1972). Another model by Fairhead and Wilson (2005) calls for episodic stress release of the African plate leading to faulting of the oceanic lithosphere followed by volcanism fed from shallow sources. Two important predictions of these lithospheric models is that the age distribution of volcanism along the Walvis Track should not display a simple linear progression and geochemical signatures of the volcanic products should be compatible with upper mantle sources.

The Walvis Track is one of the most important global hotspot tracks for the following reasons: (1) It provides crucial information on African plate motion relative to other hotspots (Duncan 1981; Morgan 1981; O'Connor and Duncan 1990; O'Connor and le Roex 1992; Müller et al. 1993). Therefore the use of time-distance relationships along the Walvis Track is a critical cornerstone in most global plate reconstructions (e.g. Norton 2000). However, the published age data for the Walvis and Rio Grande basement is now considered unreliable and obsolete with the exception of data in Rohde et al. (2013b). (2) The Tristan-Gough plume system belongs globally to the group of seven primary hotspots of Courtillot et al. (2003) and the Walvis Track is one of the few hotspot tracks on Earth that clearly connects an active hotspot system (Tristan-Gough) with CFBs (Etendeka-Paraná). Therefore this is one of the best systems for testing the "plume head - plume tail" hypothesis. (3) The Walvis Ridge is a type locality for the EM-I mantle endmember of intraplate basalts (Zindler and Hart 1986). Models for the origin of this endmember are controversial and either involve the presence of continental splinters in the oceanic lithosphere beneath the ridge, shallow recycling of subcontinental lithosphere (lower crust and/or mantle) into the upper mantle during continental breakup (e.g., Hawkesworth et al. 1986; Peate et al. 1999; Geldmacher et al., 2008) or deep mantle recycling of older continental material through mantle plumes or derivation from the lower mantle (e.g., Ewart et al. 2004; Class and le Roex, 2006). Systematic geochemical profiling along the Walvis Track in conjunction with state-of-the-art geochronology can help to distinguish further between a deep and a shallow origin for the EM-I end-member. Finally Rohde et al. (2013a) showed that the Tristan-Gough hotspot track shows geochemical zonation from the southern Walvis Ridge to the active volcanic islands. The Tristan subtrack leads from Deep Sea Drilling Project (DSDP) Sites 527 and 528 to the Tristan da Cunha Island Group, whereas the Gough subtrack leads from DSDP Site 525A to the Gough Island Group (Fig 3.2). The Gough subtrack has a more enriched isotopic composition than the Tristan subtrack as is evidenced by higher $^{207}Pb/^{204}Pb$ at a given $^{206}Pb/^{204}Pb$ isotopic composition, higher $^{87}Sr/^{86}Sr$ and lower $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ isotopic composition compared to the Tristan subtrack. It is unclear if this zonation continues further northeast along the Walvis Ridge, which would have important implications for the lower mantle source of the hotspot in its earlier history.

3.3 BIOLOGICAL INVESTIGATIONS

The main goal of the biological program was to investigate the diversity of benthic invertebrates along the Walvis Ridge on different scales (meio-, macro- and megafauna). The Walvis Ridge separates the northern Angola basin from the southern Cape basin and is described as a possible barrier preventing dispersal of benthos organisms in N to S direction or vice versa (Brandt et al., 2005). As the northbound Antarctic Benguela current drives polar water masses along the Southwest-African coast towards the Walvis Ridge, its southern flanks were supposed to host cold water adapted faunal elements with a strong Antarctic influence. If the ridge forms a dispersal barrier, one would expect the northern flanks of the ridge to be more influenced by nutrient rich coastal waters driven southwards by the much warmer Angola current. The cruise track was carefully chosen to enable a direct comparison between northern and southern benthic communities. Together with samples from the top of the ridge, we intended to test its potential barrier function and to describe in detail the differences between

the communities on both sides of this submarine hot spot track. Using commonly found invertebrate groups such as brachiopods as models, we also wanted to check whether worldwide distribution of certain brachiopod species within the genus *Eucalathis* (see Lee et al., 2008) can be corroborated by comparing new findings with results from previous cruises with molecular methods. Another aspect was the potential connectivity of brachiopod faunas across the Atlantic. As a similar phenomenon is described from the North Atlantic represented by species of the articulate brachiopod genus *Terebratulina* (Curry and Endo, 1991; Lüter and Cohen, 2002), we were interested to see whether a comparable situation was to be found in the South Atlantic as well. With the Walvis Ridge supposed to be previously connected to the Rio Grande Rise a continuous hard bottom seafloor might have been in existence in the past providing a path for dispersal of sessile hard bottom dwellers.

4. CRUISE NARRATIVE

(R. Werner, K. Hoernle, C. Lüter)

The starting point of R/V SONNE expedition SO-233 was the port of Cape Town, South Africa (Fig. 4.1) where the SO-233 scientific party arrived in the early afternoon of May 13th, 2014. After spending the night in a nice hotel, despite being a former prison, the scientists were picked up at 8:00 a.m. by the ship's agent, taken through customs and then boarded R/V SONNE (Fig. 4.2). Since the Simrad Kongsberg EM120 multi-beam echo-sounding system and the Atlas PARASOUND sub-bottom profiler of R/V SONNE did not work properly on the precursor cruise SO-232, two technicians from Kongsberg and Atlas also arrived on board on the same day. Whereas it was possible to repair the PARASOUND system, it turned out that it is impossible to improve the quality of the EM120 data since the major problem is the aging of the transducer being installed beneath the vessel and therefore out of reach. Therefore bathymetric mapping could unfortunately only be conducted in reduced extent and quality on cruise SO-233.

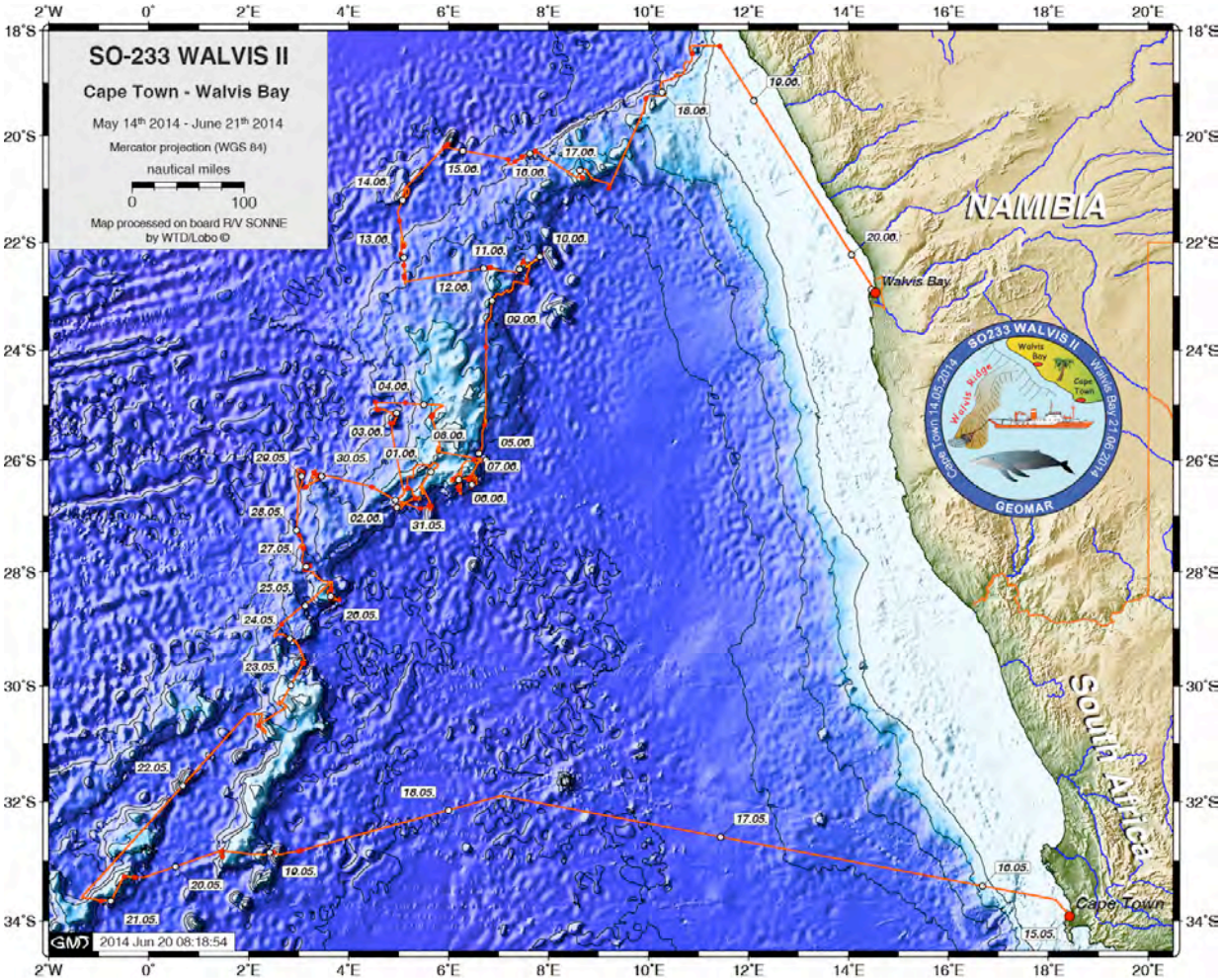

Fig. 4.1: Cruise track of R/V SONNE SO-233.

Since the laboratories were largely set up during the previous cruise, most of the scientific participants (composed of Germans, Namibians and a Russian) spent a gorgeous, sunny day in Cape Town (Fig. 4.3). Some others, however, were busy with unloading of additional scientific equipment and preparation of the TV-multi corer (TV-MUC). In the early evening of May 15th, R/V SONNE left Cape Town and headed towards the southern part of the Walvis Ridge, located ~840 nm to the west of South Africa in the southeastern South Atlantic. Unfortunately, during the first 24 hours of the cruise we were greeted by stormy weather and

therefore started our journey like a bit of a rollercoaster ride. By the second day, fortunately the clouds departed and sun shone again.

Fig. 4.2: R/V SONNE in Cape Town - a 10 minute walk to the Waterfront District (photo: Kaj Hoernle).

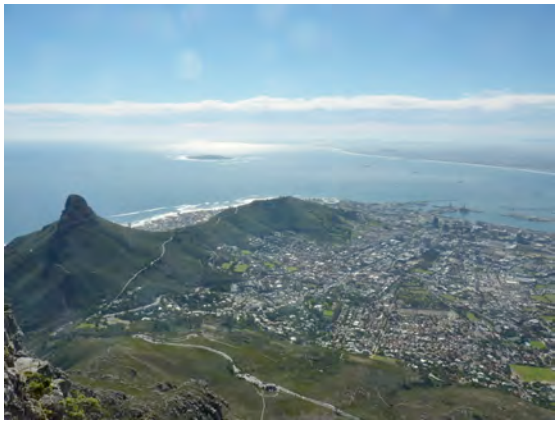

Fig. 4.3: View of Cape Town and Harbor from the Table Mountain with view of Robben Island where Nelson Mandela spent most of his 27 years imprisonment (photo: Jörg Geldmacher).

The three days of transit were used by the scientists to accommodate on board, to unpack the equipment, and to finally setup the labs. In the afternoon of May 18th, R/V SONNE arrived at the southern tip of the eastern "finger" of the Walvis Ridge (Fig. 4.1) and headed for a seamount, which appeared to be conical on the maps based on predicted (satellite-based) bathymetry. The new data compiled on SO-233, however, showed that the top region of this seamount is a large plateau covered by thick sediment layers. Right to the east of this seamount, we conducted the first TV-MUC station of our cruise on the abyssal plain in 4,900 m water depth. At that first station, the TV-MUC returned 6 tubes with surface sediment form the ocean floor. Furthermore, we deployed a CTD (Conductivity, Temperature, Density) and a rosette water sampler to sample and analyze the water column in various depths from 2,500 m water depth up to the water surface for biological studies and to update (calibrate) the sound velocity profile for EM120 echo-sounding system.

In the early morning of Mai 19th, SO-233 started rock sampling after mapping the bathymetry at the southern tip of the bifurcated southwestern part of the Walvis Ridge (c. 30° - 34°S; Fig. 4.1). The first structures that we dredged were guyot-type seamounts. Guyots have step sides and a relatively flat summit. These usually represent volcanoes that once formed ocean islands. The southeastern Walvis Ridge appears to have formed through the coalescence of former volcanoes, most of which are now guyots rising up to ~3,700 meters above the abyssal plain located at a depth of ~5,000 meters. This indicates that there was an archipelago in this area tens of millions of years ago. Seven dredge hauls conducted in that area yielded a wide range of lava fragments, volcaniclastics, and sedimentary rocks. Additionally, we deployed the TV-grab on top of a guyot seamount. The TV-grab collected soft sediments (Fig. 4.4, 4.5) with lots of shells of bivalves, snails, hexacorals and stylasterids and a large number of brachiopods dominated by the terebratuloid species *Stenosarina crosnieri*, which has not been previously found in the southeastern Atlantic Ocean. During work at one station on the southern Walvis (whale) Ridge, we were appropriately accompanied by a school of whales for about half an hour.

Unfortunately, the good weather of the past four days didn't last and from May 20th on the conditions became increasingly rough. To avoid the worst of the bad weather and high swells, we gave up work in the southernmost part of the study area in the morning of May 21st and steamed several hundred kilometers northwards. Due to the 5 - 6 m swell and high winds it was impossible to work for 24 hours. At noon on May 22nd, R/V SONNE reached a guyot-type seamount located in the northwestern section of the eastern "finger" of the Walvis Ridge (Fig. 4.1). Because of the slightly better weather conditions we were able to carry out a dredge haul at the western flank of the guyot. Unfortunately, this dredge as well as two further dredge attempts in that area recovered just sediments and Mn-crusts. On Saturday, May 24th, a TV-

MUC deployment on the Walvis Ridge also failed to return suitable samples because the MUC prematurely released in c. 2,000 m water depth due to the high swell.

Fig. 4.4 (left): The TV-grab back on board with open shovels and full payload of sediments. (photo: Kaj Hoernle).

Fig. 4.5 (above): Scientists searching the sediments from 1,100 m depths recovered by the TV-grab for organisms (photo: Kaj Hoernle).

During the third week of the cruise, the weather calmed down. A large storm with up to 8 m swell forecasted for Tuesday, May 27th, fortunately never materialized. Instead, we were blessed with sunshine, little wind, summer-like temperatures (25°C) and at the end of the week calm seas. From May 25th on we primarily mapped and sampled the "narrow central part" (c. 26° - 30°S) of the Walvis Ridge and the nearby seafloor with the dredge (Figs. 4.6, 4.7), TV-MUC and TV-grab. Although dredging proved to be difficult because of the old encrusted structures, thick sediment cover, and the smooth morphology at some places, 11 out of 17 dredge hauls carried out in that area recovered magmatic rocks from the ridge flanks and seamounts situated on the ridge. On May 30th, one of the dredge hauls was particularly successful, bringing ~ 300 kg of rock on board. This dredge was from a very steep slope at the western flank of Walvis Ridge that looked like it was part of an extinct rift system. The rocks included pillow lavas with fresh glassy rinds, resulting from very rapid cooling of the magma before it has a chance to crystallize, due to quenching from seawater. The glasses are particularly useful for geochemical analyses, because they represent the original composition of melts. To obtain fresh glass via dredging on such an old structure as the Walvis Ridge (presumably about 100 million years old at this latitude) is extremely rare, because glass is not stable when in contact with water over longer time periods and is converted to clay minerals. Many of the lava samples were also very fresh and contained large fresh feldspars, which will allow us to determine accurately the age of the samples.

The geological dredge hauls conducted at the narrow central part of the Walvis Ridge were also very successful in collecting sediment containing meiofaunal organisms within the sediment traps screwed to the inner part of the dredge. Additional sediment from that area has been recovered by a TV-grab and three TV-MUC deployments, whereas the sediment from one TV-MUC carried out on the ridge axis has been washed out in the water column during heaving. Unfortunately larger epibenthic or encrusting organisms were only rarely found on the dredged rocks. This was surprising, since we were in an area strongly influenced by the nutrient-rich Benguela current, which runs along the South African and Namibian Atlantic coasts. Accordingly, all videos recorded with the TV-MUC and the TV-grab showed a rich plankton community with shrimps, fish, jelly fish and large tunicate colonies, which are sometimes caught in the dredges. An exception was a dredge conducted on May 31st at the base of a huge guyot-like seamount on the eastern margin of the Walvis Ridge in about 1,500

- 2,000m water depth. Several big chunks of porous sediment contained lots of sponges, huge eunicid bristle worms, sipunculids, bryozoans and two species of brachiopods.

Fig. 4.6 (above): Handling of the dredge onboard R/V SONNE (photo: Kaj Hoernle).

Fig. 4.7 (right): A dredge about to come on board during the early morning hours of Christi Himmelfahrt - a national holiday in Germany. On board, crew and scientists work around the clock, seven days a week, including holidays (photo: Kaj Hoernle).

In the early morning of Mai 31st, R/V SONNE arrived at the "broad central part" of the Walvis Ridge (c. 23° - 26/27°S) (Fig. 4.1). Seafloor mapping revealed spectacular morphological features in this section of the Walvis Ridge. Its central part is formed by the Valdivia Bank, a large plateau-like structure with dimensions of ~200 km in the N-S direction and ~100 km in the E-W direction. Cutting the southern portion of the plateau is an impressive NE-SW trending horst-graben system extending for more than 250 km. It is more than 20 km wide in some places and the steep walls on both sides of the graben are up to 1 km high. Other exciting discoveries were a huge submarine landslide scarp up to 30 km across at its base on the southeast corner of the plateau. A number of very sharp, elongated ridge-like seamounts on both sides of the Walvis Ridge represent volcanism along fault zones. Most of these features are probably related to tectonic processes resulting from the interaction of the Tristan-Gough hotspot with the Mid-Atlantic Ridge (see also chapter 5.2).

Dredging of the "broad central part" of the Walvis Ridge started in its southeastern section and sampled volcanic basement of the eastern ridge margin, a seamount off the ridge, and steep scarps of the horst-graben system. Additionally, a TV-MUC yielded 7 tubes filled with sediment from the abyssal plain off this section of the ridge (Figs. 4.8, 4.9). At around midnight of June 1st/2nd, R/V SONNE left that area and headed towards the western margin of the Walvis Ridge. That day was also the half-way point of the cruise, which was good news for some and bad for others. The geologists on board worked 12-hour shifts (e.g. Fig. 4.10) from 7:45 to 19:45 and 19:45 to 7:45 and the half-way point was the date for the shift changeover. From now on the former day shift had to work at night and the former night shift switched to day, so that they now could also enjoy the occasional sunshine. On June 2nd at noon, we continued dredging at three E-W striking ridge-like seamounts on the western margin of the ridge. The dredges recovered lava fragments, volcaniclastics, and carbonates from these volcanoes. A TV-MUC aimed to sample sediments from the abyssal plain of the volcanic ridges but unfortunately failed to return samples. In the late evening of June 3rd, R/V SONNE left the western margin of the Walvis Ridge and sailed across the Valdivia Bank towards the eastern margin of the ridge (Fig. 4.1). Two attempts to sample the western flank of Valdivia Bank yielded exclusively ancient reef carbonates. Nautical maps and the predicted bathymetry show a shallow spot on the Valdivia Bank with water depths of less than 200 m in the area

around 25°50´S and 05°45´E. Extensive mapping of this area, however, revealed only flat seafloor in 1,100 ± 50 m water depth and therefore could not confirm that shallow spot.

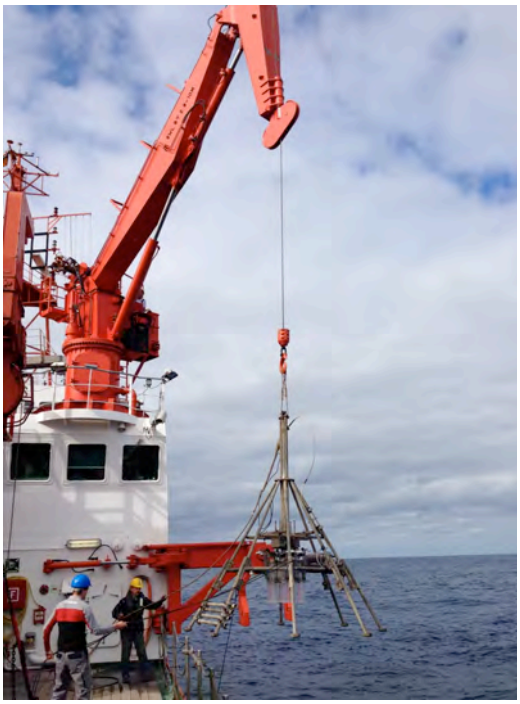

Fig. 4.8 (left): Deployment of the TV-MUC (photo: Kaj Hoernle).

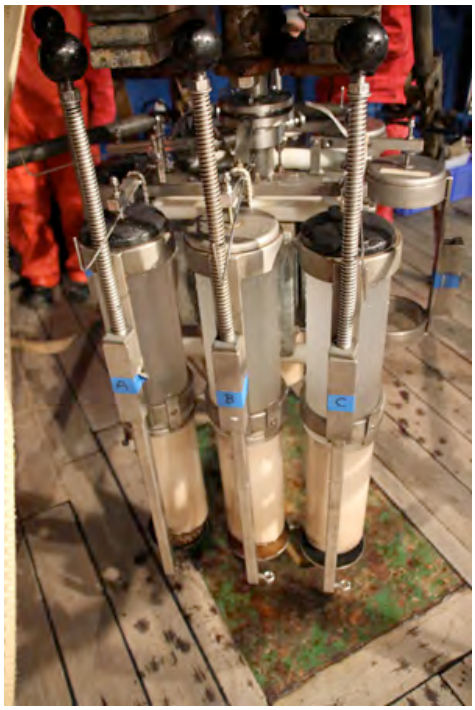

Fig. 4.9 (right): Samples of the sediment surface from the abyssal plain, recovered by the TV-MUC from more than 4,000 m water depth (photo: Kaj Hoernle).

In the late evening of June 4th, R/V SONNE arrived again at the eastern margin of the Walvis Ridge. Mapping and sampling in that area focused on the slopes of the steep landslide scarp and adjacent seamounts. Unfortunately only two dredges carried out at the northern flank of the scarp yielded magmatic rocks. A TV-grab deployment in that area, however, was rather spectacular, since the stony shoulder of a large guyot we decided to sample was crowded with organisms, such as sponges, deep water corals, see anemones, sea urchins, brittle stars and stalked crinoids. As slopes are an unsuitable ground for proper collection with the TV-grab, we drifted along to see large patches of sediment again. This lasted for nerve-breaking minutes before we hit a steep stony slope again, which was full of octocorals. At its base, we found a suitable ground for the TV-grab, which already looked promising on the video screen. When the grab came back up again and emptied its contents on the deck, we realized that we hit the remains of a highly diverse cold water coral reef containing about 10 different species of corals and a huge variety of shelly organisms associated with them (Fig. 4.11). On June 7th we sailed northwards and made several dredge attempts at the eastern flank of Valdivia Bank. Here very steep, almost vertically-sided canyons cut into the bank that we believe could only have formed as submarine canyons just below sea level at the margin of an ocean island volcano. Dredge hauls conducted at the slopes of these canyons recovered lava fragments and volcaniclastic rocks. Afterwards R/V SONNE headed on a c. 170 nm long transit to the northeastern Walvis Ridge (Fig. 4.1), which has been interrupted at half way by a successful TV-MUC station.

In the late afternoon of June 9th, we arrived at the eastern margin of northeastern section of the Walvis Ridge (c. 18° - 23°S). Here the morphology is dominated by several seamounts located on and off the ridge, such as the Ewing Seamount which rises more than 4,000 m above the abyssal plain and an unnamed guyot volcano buttressed against the Walvis Ridge with two ≥40 km long rift arms extending to the northeast and southeast. The first dredge station in this area has been carried out at the southeastern rift arm and yielded fresh volcanic rocks. The following four dredge attempts in that area, however, failed to return rocks and unfortunately even one dredge was lost and another seriously damaged. Due to the weather conditions, which spiraled downward and made work increasingly difficult, and time constrains we decided to sail c. 90 nm westward to the northwestern margin of the Walvis Ridge (Fig. 4.1). Luckily, the resulting sampling gap, which remained at the eastern margin and the

adjacent seamounts, could be filled on the follow-up cruise SO234/1 (Werner and Wagner 2014).

Fig. 4.10: Sawing rocks on board is an important but messy job (photo: Kaj Hoernle).

Fig. 4.11: Crop of a successful TV-grab deployment - the biologists have never had so much to work with (photo: Kaj Hoernle).

In the morning of June 12th, the sea had calmed down again and the weather was beautiful for the next couple of days with warm sunny days. Accordingly, SO-233 could start working again. At first we targeted a section of the northwestern ridge margin, which is marked by elongated, approximately N-S striking seamounts being situated on the edge of the ridge. Four of five dredge hauls carried out at these seamounts and the ridge basement recovered volcanic rocks. After finishing our studies in that area, it was originally planned to sail along the northwestern margin of the Walvis Ridge into the Namibian Exclusive Economic Zone (EEZ). We learned, however, that the Namibian customs has introduced new rules, which included temporary import of the vessel and duties paid on all consumables on board on arrival before starting any investigations. Since Namibia granted us a research permit without any obligations, we were unwilling to accept these claims and unfortunately it turned out that this problem could not be clarified quickly. Therefore we decided to skip any activities within the Namibian EEZ until clarification of the customs issues. Instead we sailed further northward to sample two seamounts located c. 35 - 50 nm off the ridge margin (Fig. 4.1). A TV-MUC conducted in-between the ridge margin and these seamounts returned only little sediment. The magmatic basement of both seamounts, however, could be successfully sampled. With the TV-Grab we wanted to collect invertebrate assemblages growing on hard substrate exposed on the upper slope of the eastern seamount – a difficult terrain for this device. After several attempts, we were able to grab crusts and sediments, which mysteriously had disappeared when the fine sediment cloud cleared after the shovels closed. Only a few large twigs of octocorals remained. The corals were colonized by sea anemones, soft corals, barnacles, brittle stars, feather stars and snails. Luckily the extremely fragile corals and life on them survived the more than 2,000 m journey to the surface almost completely undamaged (Fig. 4.12).

The last three working days of cruise SO-233 started with a successful TV-MUC deployment on the way back to the ridge margin in the early morning of June 15th. Afterwards we focused on a steep fault scarp on the northwestern margin of the Walvis Ridge, which extends from the base of the continental shelf for ~300 km to the southwest. Here dredging yielded a broad variety of volcanic rocks. In general, most dredge, TV-grab, and TV-MUC deployments were very successful during these three working days. Also the encrusting fauna on the dredged rocks was much more abundant near the Namibian shelf than it was in earlier samples on the central and southern parts of the Walvis Ridge. On July 16th we finally got good news concerning the issue with the Namibian customs. Thanks to the enormous support

of the German Foreign Office and the German Embassy in Windhoek, we received an official document by the Namibian authorities declaring "exemption of customs and excise duties" for German research vessels. That enabled us to complement mapping and sampling at the eastern section of the steep scarp and on a large seamount situated on the southeastern flank of the ridge. A dredge haul at the seamount returned four different lithologies of lava as well as volcaniclastic rocks (Fig. 4.13). The TV-grab has been deployed on the southern shoulder of this seamount at a depth of only 354 m. A very coarse, shelly sediment almost too hard for the TV-grab to close its shovel was colonized with large amounts of polychaete worms, crustaceans, mussels and brachiopods. Southeast of the seamount, a TV-MUC yielded 7 tubes with sediment from the abyssal plain. On June 18th the last, and very successful dredge yielded very fresh volcanic samples from a small seamount close to the northeastern end of the steep scarp, directly at the base of the Namibia continental shelf (only ~60 km from the coast).

Fig. 4.12: Stems of living isidid (bamboo) corals from 2,145 m depth with a large feather star (Crinoida) clinging to it (photo: Carsten Lüter).

Fig. 4.13: A good dredge... (photo: Kaj Hoernle).

After finishing a successful TV-MUC station on the shelf at about 400 m depth, R/V SONNE headed on the c. 300 nm long transit to our final destination Walvis Bay (Namibia) (Fig. 4.1). Two additional highlights of the last week were a jumping whale who did some corkscrew turns in the air, and the final party after working without a day off for more than four weeks. Of course, the scientists had to get up early the next day after the party in order to thoroughly clean the labs, pack samples and equipment into the container, and prepare everything for the follow-up cruise SO-234/1. In the morning of June 20th, we arrived on time off the port of Walvis Bay (Figs. 4.14). Due to the full utilization of the port, however, R/V SONNE lay in the roads for more than 8 hours before the vessel could finally enter the port in the late afternoon and moor at the dock (Fig. 4.15). On Saturday, June 21st, the scientists disembarked, officially ending the cruise SO-233.

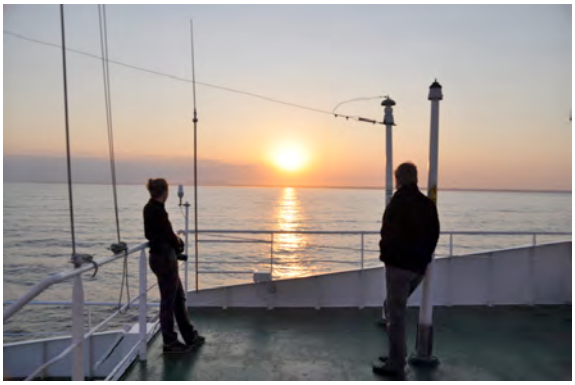

Fig. 4.14: Sunrise at the Skeleton Coast north of Walvis Bay (photo: Franziska Matz)

Fig. 4.15: R/V SONNE in Walvis Bay (photo: Matthias Schroeder).

Complementing extensive multi-beam mapping and sediment echo-sounding, a total of 91 deployments of various devices (dredge, TV-MUC, TV-grab, CTD) have been carried out during R/V SONNE cruise SO-233 in an average water depth of 3,020 m. Ten of 13 TV-MUCs yielded sediment samples, 5 of 6 TV-grab deployments recovered sediments and/or macro fauna, one of them also volcanic rocks. Seventy-one dredge hauls have been conducted. Of these, 28 delivered massive lavas, 24 volcaniclastic rocks including breccias containing lava fragments, 22 sedimentary rocks, and 11 Mn-Fe-Oxide crusts and nodules. In summary, SO-233 achieved its major goals, i.e. bathymetric mapping and representative hard rock sampling of all major geomorphological units of the Walvis Ridge and of associated features. The SO-233 sample set represents the most detailed sampling of the Walvis Ridge to date. Figure 4.16 shows an overview of the sampling stations and the ship´s track of R/V SONNE cruise SO-233. For more detailed maps see chapter 5.2.

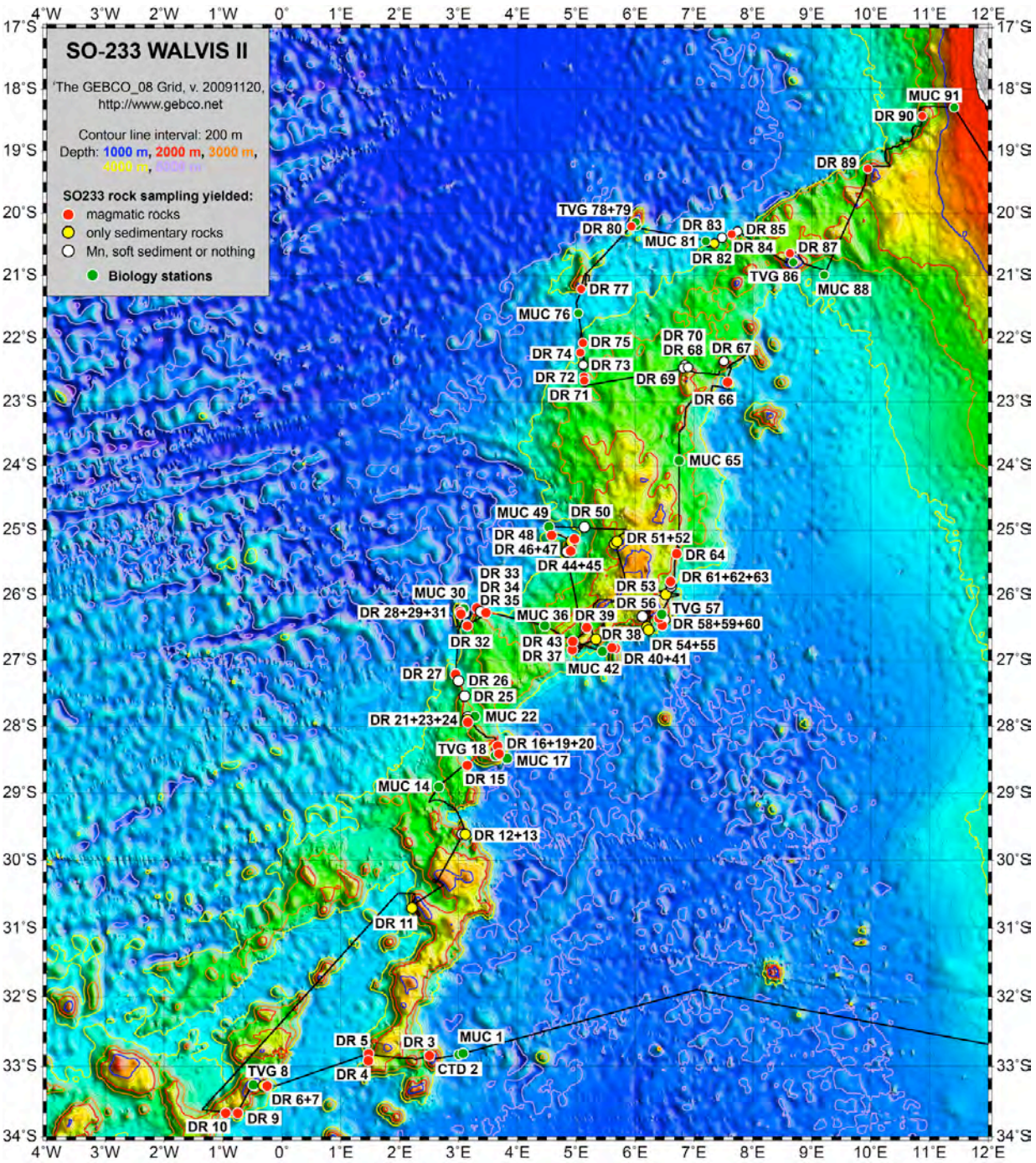

Fig. 4.16: Ship´s track (black line) and sampling stations (colored dots) of R/V SONNE cruise SO-233 WALVIS II (data base for bathymetry: The GEBCO_08 Grid, version 20091120, http://www.gebco.net).

5. BATHYMETRY AND ROCK SAMPLING

(K. Hoernle, R. Werner, M. Portnyagin, J. Geldmacher, R. Golowin, S. Homrighausen, J. Itengula, K. Junge, A. Kipf, I. Mbidi, A. Schwindrofska, B. Stiller, S. Wind)

5.1 METHODS

5.1.1 Bathymetry (Simrad Kongsberg EM120)

Data Acquisition

Since June 2001 the R/V SONNE has been equipped with a Simrad Kongsberg EM120 multi-beam echo sounder system for continuous mapping of the seafloor. The EM120 system consists of several units. A transmitter/receiver transducer array is fixed in a mills cross below the keel of the vessel. A preamplifier unit contains the preamplifiers for the received signals. The transceiver unit contains the transmitter and receiver electronics and processors for beam-forming and control of all parameters with respect to gain, ping rate and transmit angles. The system has serial interfaces for vessel motion sensors, such as roll, pitch and heave, external clock and vessel position. The system also includes an Intel based (Windows XP) operator station. The operator station processes the collected data, applying all corrections, displays the results and logs the data to internal or external disks. The EM120 system has an interface to a sound speed sensor, which is installed near by the transducers.

The EM120 system uses a frequency of about 12 KHz with a whole angular coverage sector of up to 150° (75° per port-/starboard side, Fig 5.1.). When one ping is sent, the transmitting signal is formed into 191 beams by the transducer unit through the hydrophones. The beam spacing can be defined in equidistant or equiangular modes or in a mix of both. The ping-rate depends on the water depth and the runtime of the signal through the water column. The variation of angular coverage sector and beam pointing angles was set automatically. This optimizes the number of usable beams.

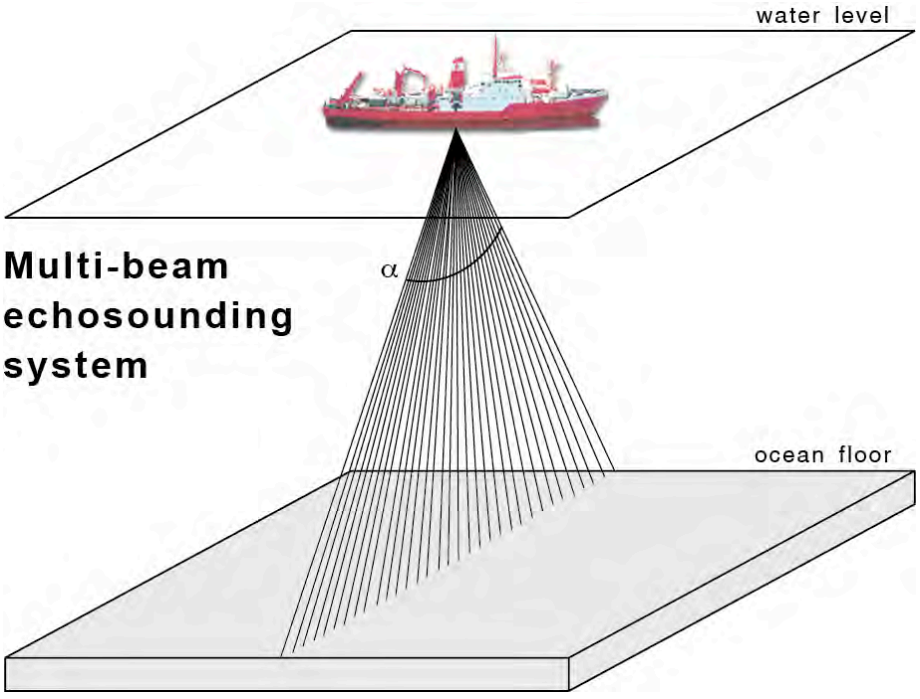

Fig. 5.1: Schematic sketch illustrating the principle mode of operation of multi-beam echo-sounding systems. The whole angular coverage sector (α) of the Simrad Kongsberg 120 system amounts is up to 150°.

During a survey the transmitter fan is split into individual sectors with independent active steering according to vessel roll, pitch and yaw. This forces all soundings on a line perpendicular to the survey line and enables a continuous sampling with a complete coverage. Pitch and roll movements within ±10 degrees are automatically compensated by the software.

Thus, the EM120 system can map the seafloor with a swath width about up to six times the water depth. The geometric resolution depends on the water depth and the used angular coverage sector and is less than 10 m at depths of 2,000 - 3,000 m.

The accuracy of the depth data obtained from the system is usually critically dependent upon weather conditions and the use of a correct sound velocity profile. During SO-233 a sound profile has been determined using a CTD at the beginning of the cruise when R/V SONNE arrived in the working area, ensuring the use of the correct sound velocity on this cruise.

Data Processing

The collected data were processed onboard with the EM120 coverage software. The post-processing was done on two other workstations by the accessory Neptune software. The Neptune software converted the raw data in 9 different files which contains information about position, status, depth, sound velocity and other parameters and are stored in a SIMRAD binary format.

The data cleaning procedure was accomplished by the Neptune software. The first step was to assign the correct navigational positions to the data without map projections. The second step was the depth corrections, for which a depth threshold was defined to eliminate erratic data points. In the third part of post-processing statistical corrections were applied. Therefore, a multitude of statistical functions are available in a so called BinStat window where the data are treated by calculating grid cells with an operator-chosen range in x and y direction. Each kind of treatment is stored as rule and has an undo option. For the calculation the three outermost beams (1 - 3 and 188 - 191) were not considered. Also a noise factor, filtering and a standard deviation were applied to the calculated grid. All this work was done by the system operators of R/V SONNE. After the post-processing the data have been exported in an ASCII x,y,z file format with header information and was transferred to other workstations where assembling, griding and contouring with the GMT software (Wessel and Smith 1995) and/or Fledermaus version 7.3.4. (by Interactive Visualization Systems Inc.) were performed.

5.1.2. Sediment Echo-Sounding (Atlas PARASOUND)

Sub-bottom profilers (or sediment echo-sounding systems) are used to display sub-seafloor geological structures as, for example, marine sediment successions. The ATLAS PARASOUND sub-bottom profiler acts as a low-frequency sediment echo-sounder and as high-frequency narrow-beam sounder to determine the water depth. The sub-bottom profiler is based on the parametric effect, which is produced by additional frequencies through nonlinear acoustic interaction of finite amplitude waves. In principle, if two sound waves of similar frequencies (18 kHz and e.g. 22 kHz) are emitted simultaneously, a signal of the difference frequency (e.g. Secondary Low Frequency of 4 kHz) is generated for sufficiently high primary amplitudes. This new component is traveling within the emission cone of the original high frequency waves, which are limited to an angle of only 4.5° for the equipment used (Fig. 5.2.). The resulting footprint size of only 7 % of the water depth is much smaller than for conventional systems and both vertical and lateral resolution is significantly improved.

The ATLAS PARASOUND system is permanently installed on R/V SONNE. The hull-mounted transducer array has 128 elements within an area of 1 m^2. It requires up to 70 kW of electric power due to the low degree of efficiency of the parametric effect. The PARASOUND sub-bottom profiler on R/V SONNE is equipped with the digital data acquisition software from ATLAS Hydrographic, which is subdivided in ATLAS Parastore and ATLAS Hydromap Control. ATLAS Parastore allows the buffering, transfer and storage as well as the visualization of the digital echograms at very high repetition rates. ATLAS Hydromap Control is responsible for user defined modifications of the system (e.g. pulse rate or mode) and supports the operator in running the system properly.

PARASOUND data have been recorded during all SO-233 bathymetric surveys and on all transits outside the South African EEZ. During the cruise, however, only online profiles displayed on the screen have been used for the selection of appropriate sites for TV-MUC and TV-grab deployments. The data acquisition included PHF and SLF data. All data have been copied on an external hard disk and sorted by the operator into folders according to data type (PHF, SLF / ASD, PS3, SEGY) and recording dates (0 to 24 hours UTC). After the cruise the

entire PARASOUND data set will be transferred to data co-operating specialists for further shore based processing and analyses and is archived in international data banks.

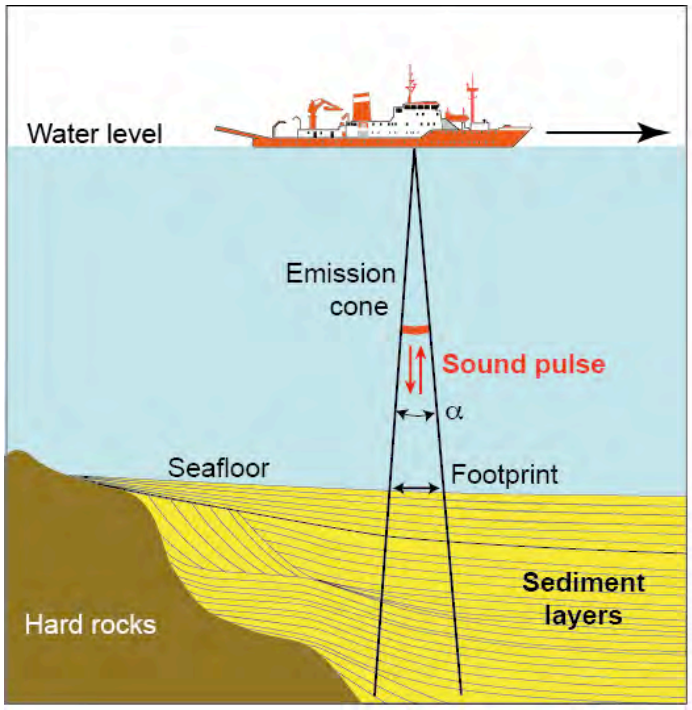

Fig. 5.2: Schematic sketch illustrating the principle mode of operation of sub-bottom profilers. The extremely narrowed beam of the ATLAS PARASOUND system of 4.5° (α) allows to resolve even small-scale bottom structures and offers a deeper penetration of up to ~200 m into the seafloor.

5.1.3 Dredging, Site Selection, and Laboratory Work

Rock sampling on SO-233 was carried out using rectangular chain bag dredges. Chain bag dredges are similar to large buckets with a chain bag attached to their bottom and steel teeth at their openings, which are dragged along the ocean floor by the ship´s winch.

General station areas were chosen on the basis of a number of existing datasets. These mainly include predicted bathymetry, derived from gravity data and ship depth soundings (etopo by Smith and Sandwell [1997] and "The GEBCO_08 Grid, version 20091120", http://www.gebco.net) and published data, maps, and profiles.

The final selection of dredge sites was critically dependent on detailed multi-beam echo-sounding surveys carried out at each site before dredging. Final positioning of the vessel over the dredge station was based on the bathymetric data gained on these surveys including considerations of wind, swell and drift conditions. Dredge tracks were usually located - depending on the morphology of the structures - on steep slopes, at plateau edges, at scarps, canyon walls, and on the flanks of cones and larger seamounts. This was mainly done to avoid areas of thick sediment cover.

Shipboard Procedure

Once onboard, a selection of the rocks were cleaned and cut using a rock saw. They were then examined with a hand lens and microscope, and grouped according to their lithologies and degree of submarine weathering. The immediate aim was to determine whether material suitable for geochemistry and radiometric age dating had been recovered. Best suitable samples have an unweathered and unaltered groundmass, empty vesicles, glassy rims (ideally), and any phenocrysts that are fresh. If suitable samples were present, the ship moved to the next station. If they were not, then the importance of obtaining samples from the station was weighted against the available time.

Fresh blocks of representative samples were then cut for post-cruise thin section and microprobe preparation, geochemistry and further procedures to remove manganese and alteration products and/or to extract glass (if applicable). Each of these sub-samples, together

with any remaining bulk sample, was described, labeled, and finally sealed in either plastic bags or bubble wrap for transportation to GEOMAR or cooperating institutions.

Shore Based Analyses

Magmatic rocks sampled by R/V SONNE from the ocean floor will be analyzed using a variety of different geochemical methods. The ages of whole rocks and minerals will be determined by $^{40}Ar/^{39}Ar$ laser dating. Major element geochemistry by X-ray fluorescence (XRF) and electron microprobe (EMP) will constrain magma chamber processes within the crust, and also yield information on the average depth of melting, temperature and source composition to a first approximation. Phenocryst assemblages and compositions will be used to quantify magma evolution, e.g. differentiation, accumulation and wall rock assimilation. Petrologic studies of the volcanic rocks will also help to constrain the conditions under which the melts formed (e.g., melting depths and temperatures). Further analytical effort will concentrate on methods that constrain deep-seated mantle processes. For example, trace element data measured by inductively coupled plasma mass spectrometry (ICP-MS) will help to define the degree of mantle melting and help to characterize the chemical composition of the source. Long-lived radiogenic isotopic ratios obtained by Thermal Ionization Mass Spectrometry (TIMS) and Multi-collector ICP-MS such as $^{87}Sr/^{86}Sr$, $^{143}Nd/^{144}Nd$, $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{208}Pb/^{204}Pb$, and $^{176}Hf/^{177}Hf$ are independent of the melting process and reflect the long term evolution of a source region and thus serve as tracers to identify mantle and recycled crustal sources. Additionally, morphological studies and volcanological analyses of the dredged rocks will be used to constrain eruption processes, eruption environment and evolution of the volcanoes. Through integration of the various geochemical parameters, the morphological and volcanological data and the age data, the origin and evolution of the sampled structures can be reconstructed.

Non-magmatic rocks and Mn-Fe oxides yielded by dredging can be transferred to co-operating specialists for further shore-based analyses.

5.2 ROCK SAMPLING REPORT AND PRELIMINARY RESULTS OF BATHYMETRIC MAPPING

The following section mainly gives background information and short summaries of the features sampled and/or mapped on SO-233 and on the rock types obtained by dredging but also presents some preliminary interpretations of bathymetric data and rock assemblages. Refer to Appendix I and II for exact latitude, longitude, and depth of dredge sites and more detailed rock descriptions. Figure 4.16 shows an overview map with all SO-233 sampling sites. Distances, dimensions and heights given in this chapter are approximate and are only included to give a rough idea of dimensions of morphological features. Distances between seamounts are given between the seamount tops. All photos shown in this chapter are taken by GEOMAR.

5.2.1 The Bifurcated Southwestern Part of Walvis Ridge (DR3 - 13)

The bifurcated southwestern part of the Walvis Ridge extends from c. 34° to 29°S and comprises two c. 450 km long, NE-SW-trending ridge-like arms (here called eastern and western finger) and a sub-parallel trending seamount chain in-between the ridges (Fig. 5.3). SO-233 rock sampling and mapping focused on the eastern finger and the central seamount chain since the western finger has been already investigated by the complementary R/V MELVILLE MV1203 cruise of our U.S. partners (Fig. 5.3).

The first structure we investigated, at the southernmost end of the eastern finger at ~33°S, was a volcanic guyot, consisting of steep sides and a relatively flat summit (Fig. 5.4a). Guyots usually represent volcanoes that once formed ocean islands. After the volcano becomes extinct, the waves erode the island to sea level, forming a flat top on the volcano. As the crust beneath the volcano cools, the guyot subsides and the former wave cut top of the guyot sinks beneath sea level. As it is typical for guyots, the top plateaus are never completely flat, but form gentle domes. This inward shoaling of the plateaus is consistent with subsidence occurring contemporaneously with erosion at sea level to form the plateaus. The abyssal plain adjacent to the sampled guyot is located at a depth of ~4,800 m (eastern side) and ~3,200 m (western side). The erosional plateau is located between ~1,400 to 1,000 m depths. On the

northeastern corner of the plateau a younger, post-erosional (i.e. post-dating erosion of the former island to sea level forming the oval shaped main top plateau) volcanic structure forms a secondary guyot with a top between ~600 and 510 m (Fig. 5.4a).

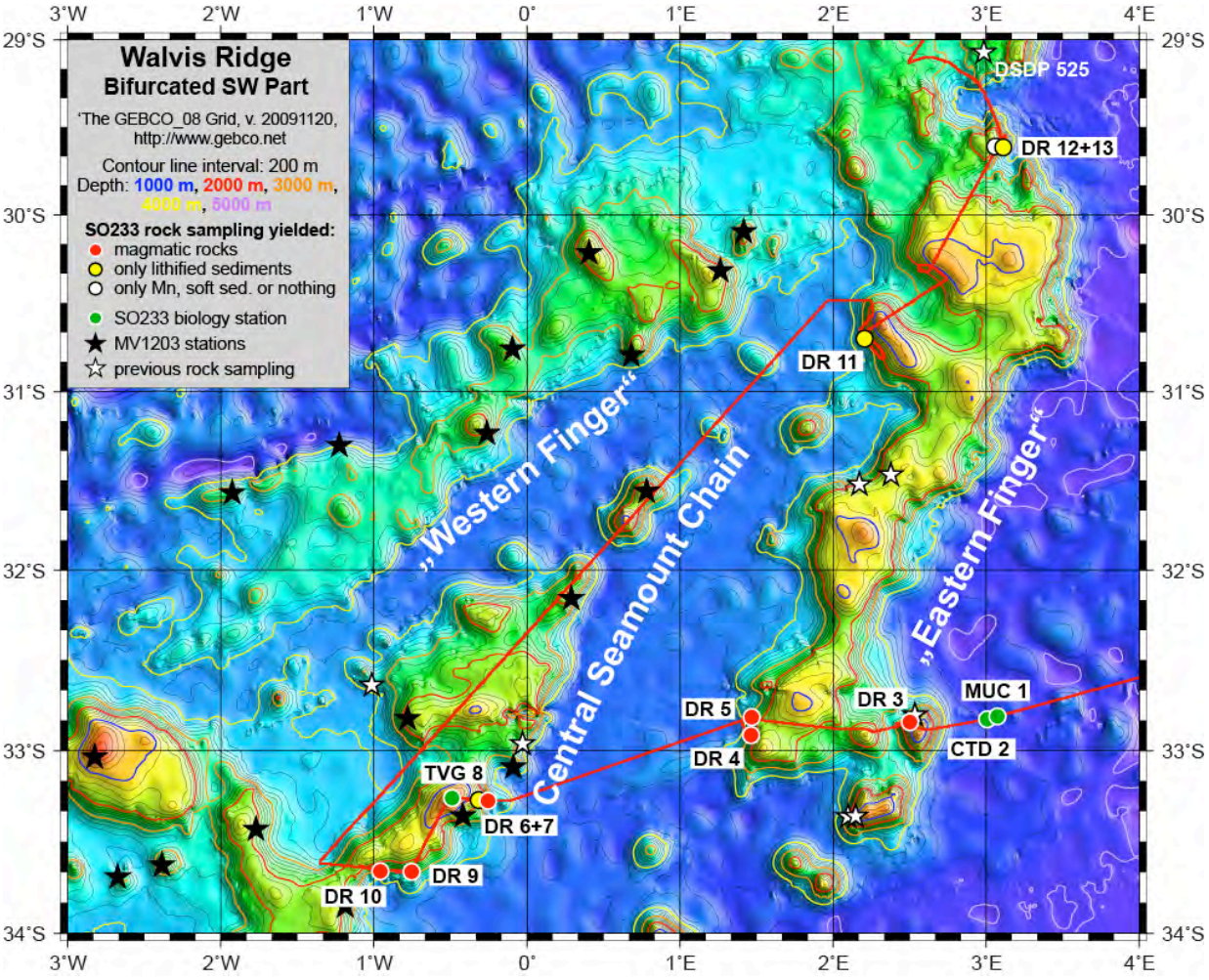

Fig. 5.3: Overview map of the bifurcated southwestern part of the Walvis Ridge (based on "The GEBCO_08 Grid, version 20091120", http://www.gebco.net). Dots mark SO-233 sampling stations, black stars R/V Melville cruise MV1203 stations, white stars previous rock sampling stations, and red lines the SO-233 ship´s track.

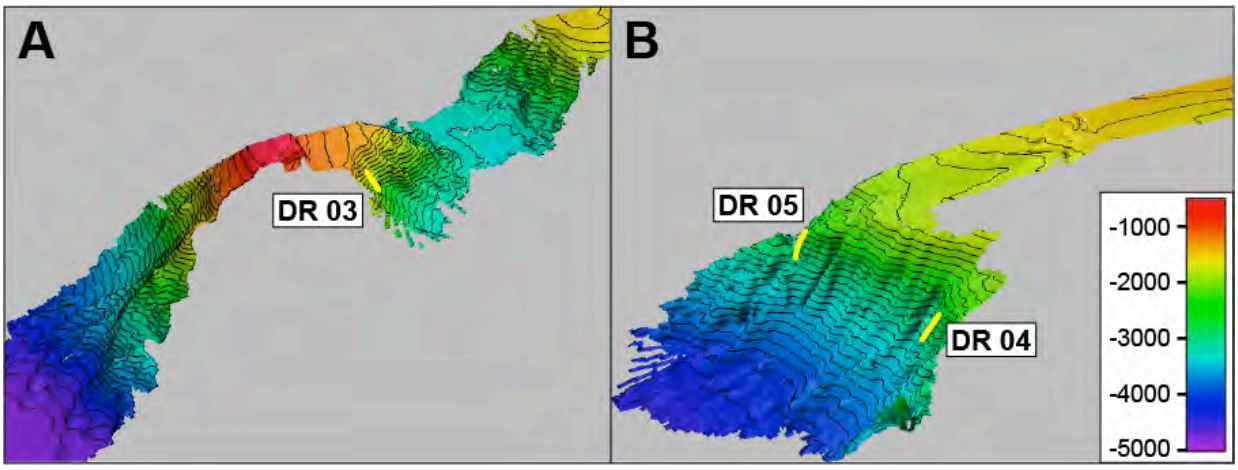

Fig. 5.4: 3D-maps showing ship´s tracks crossing guyots at the southern tip of the eastern finger of Walvis Ridge and SO-233 dredge tracks DR03 - 05 marked by yellow lines (A: view from NE to SW; B: view from SW to NE). Note the two different levels of the top plateau of the guyots shown on map A. The maps are based on multi-beam data recorded on SO-233 (exaggeration: 3x; interval of contour lines: 100 m).

Dredge haul DR03 has been carried out at the upper western slope of this guyot from c. 2,160 to 1,580 m below sea level (b.s.l.) and returned a couple of angular lava fragments (Fig. 5.5), a variety of volcaniclastic rocks, and manganese crusts. The lavas are porphyritic with c. 5 - 10% altered olivine (<3 mm) and 5 - 10% fresh feldspar phenocrysts (up to 1 mm). Groundmass alteration ranges from relatively fresh to more yellowish-brown oxidized areas. The groundmass contains small brownish and black minerals (clinopyroxene?) and c. 20% partly filled vesicles. A greenish-gray, highly altered rock with distinct layering dominates among the volcaniclastic rocks. Minor lithologies include highly altered volcanic breccias and a brownish sediment containing a few recognizable volcanic clasts. DR03 aimed to sample the main edifice of the guyot but we note that displaced rocks from the late-stage (post-erosional) secondary guyot could also have been collected.

Fig. 5.5 (left): Moderately altered porphyritic lava from a guyot at the southern tip of the eastern finger of Walvis Ridge.

Fig. 5.6 (right): Mn-encrusted volcanic breccia. Note the fairly fresh interior of the large lava clast.

Going westwards, R/V SONNE crossed two additional guyots. West of the first guyot, we passed over the second guyot with a dome-shaped top rising from ~1,600 m at the edge to 1,430 m in the center. Still further west, we crossed what may have been a rift arm of this or the adjacent guyot, which rises to depths as shallow as ~2,000 m. Subsequently, we crossed a third guyot, being located on the western margin of the eastern finger, with an erosional top between ~1,600 to at least 1,370 m (Fig. 5.4b). Dredge hauls DR04 and DR05 have been conducted at the middle part of the western flank of this guyot from 3,040 to 2,570 m b.s.l. and 2,900 to 2,500 m b.s.l., respectively. DR04 yielded only one small, Mn-encrusted piece of a volcanic breccia consisting of up to 2 cm-sized completely altered lava fragments in a fine-grained matrix and one larger lava clast (c. 7 x 3 cm) which surprisingly has a fairly fresh gray core surrounded by a greenish-brownish rim (Fig. 5.6). The lava consists of ~5% altered olivine (< 2 mm), ~5% up to 3 mm large clinopyroxenes (or amphibole?), and ~5% feldspar phenocrysts in a dense, fine grained matrix. This clast may be suitable for geochemical analytics but needs careful preparation. DR05 aimed to sample the same slope c. 10 km further north in order to obtain more and ideally better material from this guyot. Similar to DR04, however, the dredge returned only one piece of a volcanic breccia and a completely altered, reddish-yellow volcaniclastic (?) rock fragment. The breccia consists of subrounded, up to 6 cm-sized lava clasts in a fine to medium grained calcitic matrix. Two parts containing the biggest and freshest clasts (DR05-1-B and -C) have been separated on board for further analytics. The lava clasts contain 5 - 10% altered, up to 2 mm-sized olivine and feldspar phenocrysts in a fine-grained vesicular matrix (5 - 20%). Approximately half of the vesicles are filled with calcium carbonate and many of the clasts are penetrated by calcite veins.

Further to the west the water depth increased to ~4,600 m until R/V SONNE reached the ridge-like seamount chain between the two bifurcated arms at the end of the Walvis Ridge (Fig. 5.3). A huge guyot at the southern section of the chain has a top plateau located between ~1,600 and ~1,160 m (Fig. 5.7). The similar depth ranges of the tops for all guyots mapped until now suggest that these volcanic islands were eroded to sea level during a similar time interval and thus existed contemporaneously. Late-stage volcanism took place on the first

guyot (Fig. 5.4a) after it subsided beneath sea level forming a new island that was eventually also eroded to sea level. Approximately 1,200 m of subsidence occurred after formation of the older guyot platform and ~500 m after the late-stage (post-erosional) guyot platform.

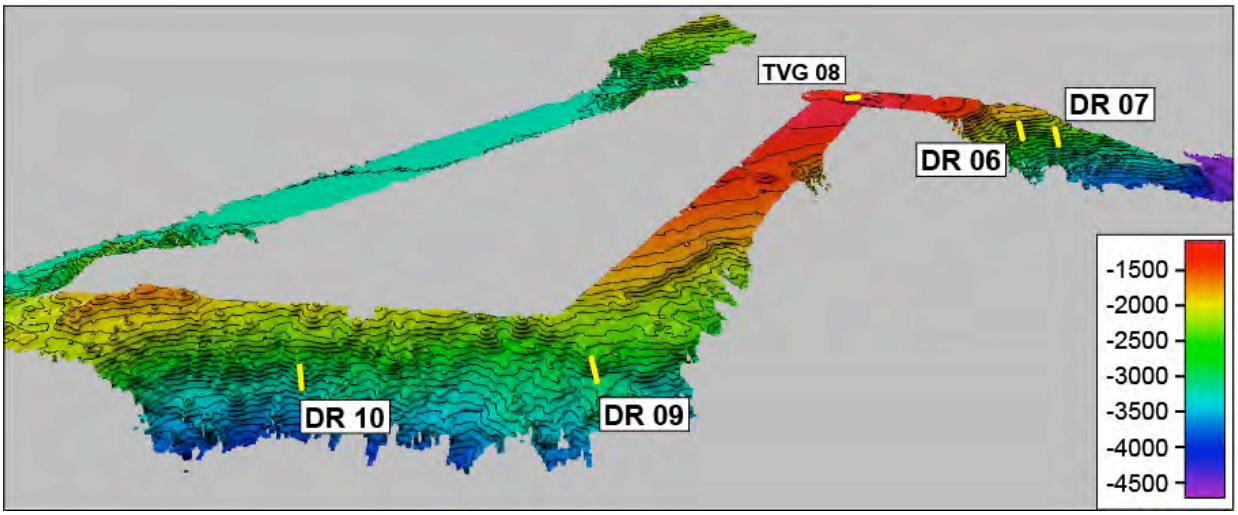

Fig. 5.7: 3D-map showing ship´s tracks crossing the huge guyot in the southern section of the central seamounts chain and SO-233 dredge tracks DR07 - 10 marked by yellow lines (view from S to N). Data source, exaggeration, and contours as in figure 5.4.

Dredge stations DR06 and 07 have been carried out at the eastern flank and DR09 and 10 at the southern flank of the huge guyot (Fig. 5.7). DR08 was located beneath a small shoulder at the upper slope from 2,450 to 2,030 m b.s.l. but yielded again just one small fragment of Mn-encrusted volcaniclastic breccia. Two clasts have been separated from the breccia for further preparation. A 4 x 4 cm-sized lava clast (sample DR06-1A) is largely aphyric with a few brownish-yellowish patches which may represent completely replaced former olivine phenocrysts. The groundmass is fine grained and has ~10% vesicles which are partly filled with calcium carbonate or manganese. Notably the clast appears to be fairly fresh in the core and contains lots of small fresh groundmass feldspar, so that careful preparation may allow age dating. The second clast (sample DR06-1B) is similar to DR06-1A but much more altered. DR10 targeted for the middle section of the same slope (2,640 m to 2,310 m b.s.l.) and yielded sedimentary rocks containing lots of varicolored, sand-sized fragments of unclear nature (tephra? minerals?) in a white to yellowish matrix. Altogether ten samples (DR07-1 to -10) have been taken from these sediments in case thin section evaluation reveals that the small fragments are minerals, which may be suitable for analyses and/or dating. Dredge station DR09 (2,900 m to 2,500 m b.s.l.) was located ~75 km southwest of DR07 along the slope of a small cone on the southern flank of the guyot. This dredge returned a few volcaniclastic rocks and Mn-crusts. The volcaniclastics consist of up to 5 mm-sized sub-rounded and angular altered clasts in a white groundmass. Many of the clasts contain 5 - 10% small white minerals (feldspar?). The next dredge DR10 was placed ~19 km further west at a small noose (cone?) in the mid-section of the same slope and yielded again only a few volcaniclastic rocks. The rocks consist of rounded and sub-angular reddish-gray unsorted clasts (ø 1 mm - 3 cm, <10% vesicularity) cemented by a white matrix. Some of the clasts may be suitable for geochemical analyses after careful preparation.

Several other guyots were crossed further to the north but not sampled, for example, a guyot at ~31°40'S and 0°40'E in the northern section of the seamount chain with a top plateau between ~1,600 and 1,280 m b.s.l. Back at the eastern finger R/V SONNE mapped a guyot on its northwestern margin with top plateau between ~1,600 and 1,360 m b.s.l.. Dredge haul DR11 (Fig. 5.8) aimed for the middle section of its western slope from 3,000 to 2680 m b.s.l. but yielded only cobbles of weakly consolidated brownish sediment. Another guyot directly to the northeast in the center of the eastern finger (Fig. 5.8) has a plateau between ~1,400 and 1,000 m b.s.l., similar to the depths of the first guyot.

Two dredge attempts (DR12 and 13) have been made on the eastern flank of northern end of the eastern finger (Fig. 5.8) but both failed to recover magmatic rocks. DR12 has been

conducted at the upper slope from 2,400 m to 2,000 m b.s.l. and contained one large block and several smaller pieces of limestone representing relicts of a fossil coral reef. Dredge haul DR13 has been placed downslope of DR12 from 2,550 m to 2,300 m b.s.l. to avoid the reef carbonates which obviously cover this structure but returned only a few Mn-crusts.

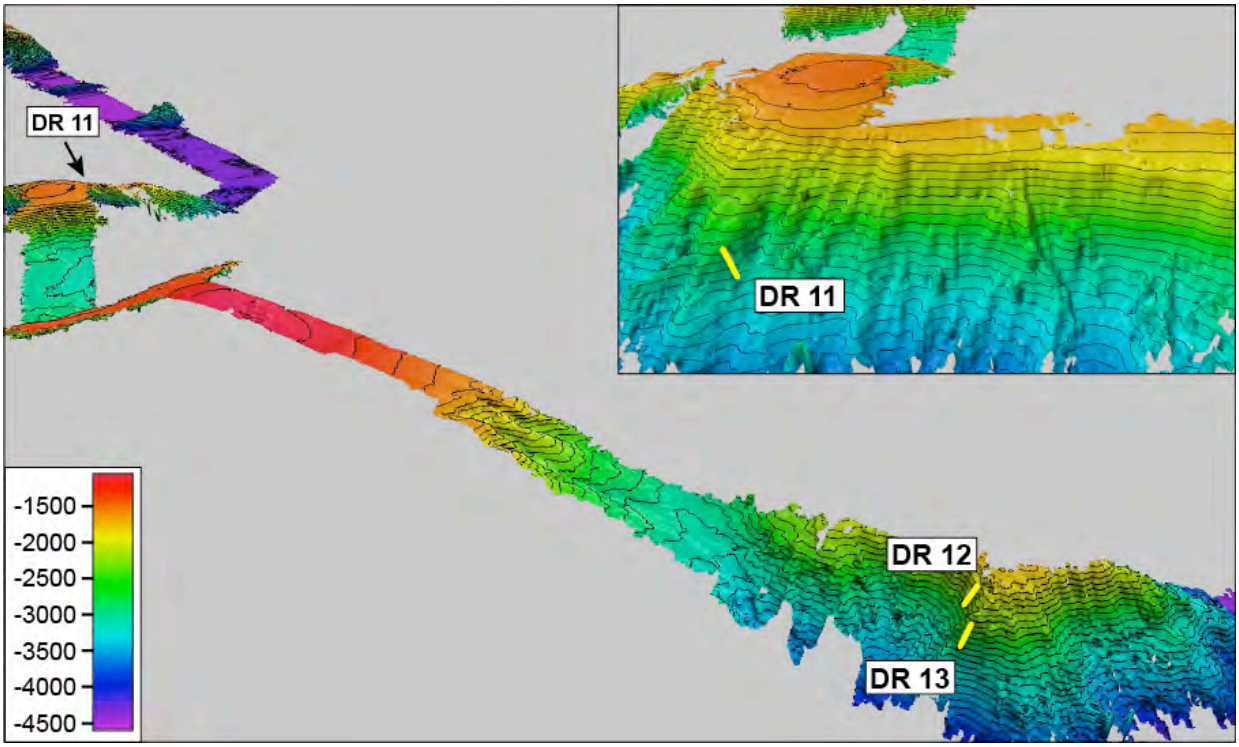

Fig. 5.8: 3D-map showing ship´s tracks crossing the northern section of the eastern finger and SO-233 dredge tracks DR11 - 13 marked by yellow lines (view from E to W, insert from SW to NE). Data source, exaggeration, and contours as in figure 5.4.

In summary, the guyots in the bifurcated southwestern part of Walvis Ridge indicate that an archipelago of islands existed when this part of the Walvis Ridge was formed, at ~50-70 Ma (based on age data from Rohde et al., 2013b), with the guyots in the south likely being younger than those in the northern part of that area. Basically the eastern finger and the seamount chain of the southeastern part of Walvis Ridge appears to have formed through the coalescence of former (island) volcanoes. This hypothesis of a drowned archipelago is consistent with the dredged rock assemblage. The lavas probably represent the basement of the volcanoes, the volcaniclastic rocks may have formed by explosive volcanic activity and/or reworking in shallow water depth, and the reef carbonates developed on the tops of the eroded volcanoes during an early stage of subsidence.

5.2.2 The Narrow Central Part of Walvis Ridge (DR15 - 34)

The morphology of the narrow part of the Walvis Ridge (narrow referring to the NW-SE direction perpendicular to plate motion) between 29°S and 26°S is controlled by tectonic extensional features. Two sub-parallel curved trough-like features between 2°40', 4°00'E strike NNW-SSE (Fig. 5.9): (1) The more southwestern trough-like feature extends roughly from 28°45'S, 3°20'E to 27°00´S, 2°45'E and appears to continue along the seafloor beyond the Walvis Ridge to at least 26°00´S, 2°00´E, and (2) the trough-like feature to the northeast extends roughly from 28°20'S, 3°50'E to 27°00´S, 3°00´E and appears to continue beyond the Walvis Ridge to at least 26°00´S, 2°50'E. We interpret these structures as extensional features and they appear to develop into east-west directed fracture zones on the seafloor.

Dredge station DR15 was conducted at the southern flank of the southwestern trough-like feature from 3,940 m to 3,660 m b.s.l. (Fig. 5.10). The dredge yielded one large lava block (34x17x17 cm) and one small lava fragment. The lava is porphyritic with at least 25% altered, up to 8 mm-sized olivine and ~2 % fresh, up to 3 mm-sized plagioclase phenocrysts. The

groundmass appears to be fairly fresh in places and contains interstitial plagioclase, black needle-like minerals (pyroxene?), and 20% partly filled vesicles.

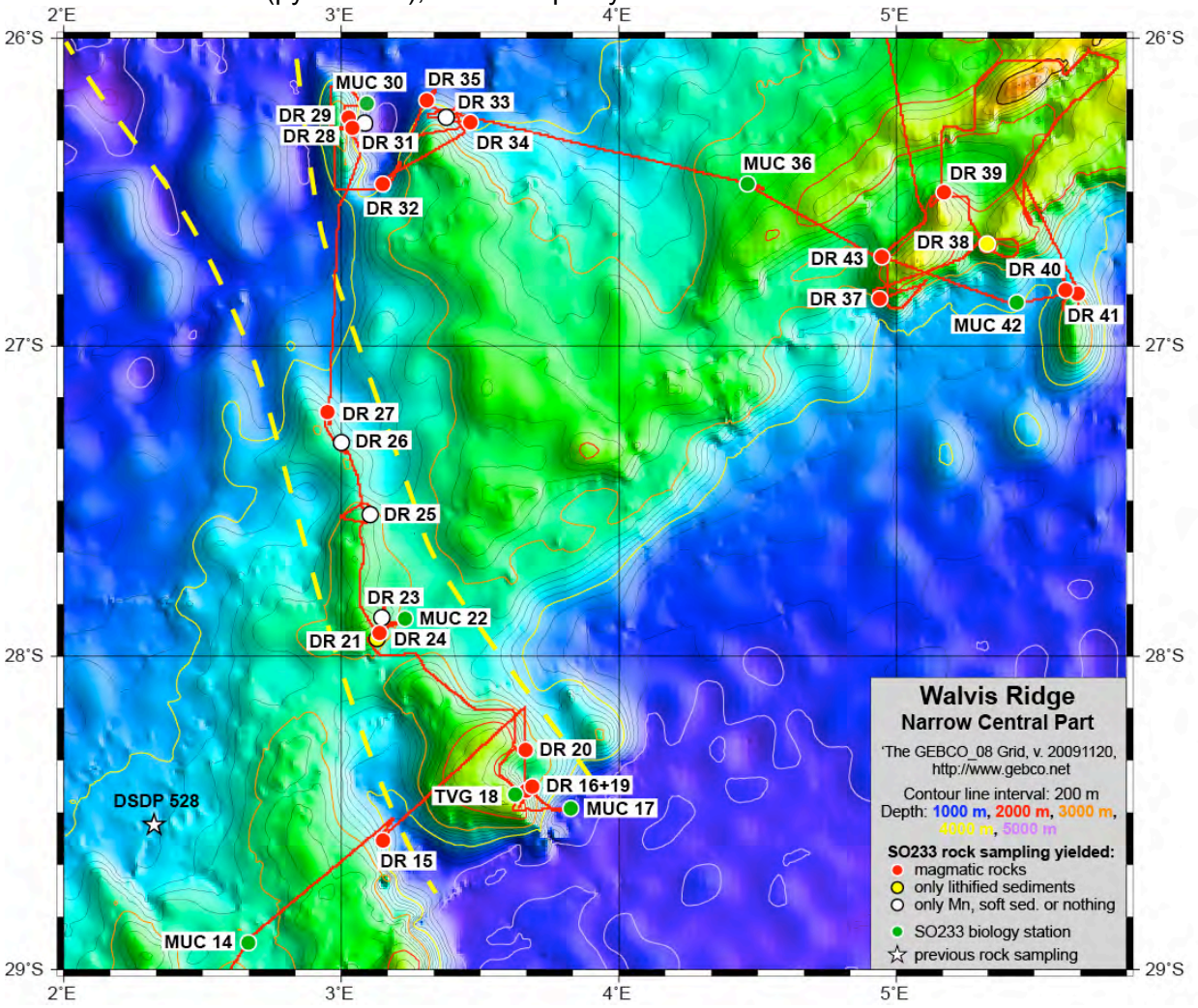

Fig. 5.9: Overview map of the narrow central part of the Walvis Ridge (based on "The GEBCO_08 Grid, version 20091120", http://www.gebco.net). Dots mark SO-233 sampling stations and stars previous rock sampling stations, and red lines the SO-233 ship´s track. The dashed yellow lines show the axes of the two trough-like structures cutting the narrow central part of the ridge. Note that station DR37 - DR43 belong morphologically to the broad central part of Walvis Ridge and are described in the next chapter.

The next three dredge stations (DR16, 19, 20) sampled a large guyot with a top plateau between ~2,100 m and 1,600 m b.s.l. (Figs. 5.9, 5.10), which forms the southern end of the ridge-like structure in-between the two trough-like extensional structures. DR16 was conducted at the southwestern wall of very steep, narrow, NW-SE striking canyon at the northeastern base of the guyot between 3,630 m and 3,190 m b.s.l. and returned one lava clast (Fig. 5.11) and some coral fragments. The lava is almost dense with only a few filled vesicles in a fine-grained, mostly fresh groundmass with only a few greenish altered spots (chlorite). Minerals are generally small (< 1 mm) and macroscopically difficult to identify. Pyroxene seems to be more abundant as olivine but thin section examination needs to clarify if this rock is ankaramitic or tholeiitic. DR19 has been carried out upslope of DR16 from 2,450 m to 2,110 m b.s.l. at the upper northeastern flank of the quyot. Only one Mn-encrusted, 19x10x9 cm-sized volcaniclastic rock fragment has been recovered. This rock contains one large (> 10 cm) and various smaller lava clasts in a fine-grained, white matrix (Fig. 5.12). Two clasts have been separated for further preparation. The clasts are highly porphyritic with ~30% medium-altered to fresh plagioclase (up to 1 cm), ~2 - 5% altered olivine (< 0,5 cm), and ~1 - 3% small black minerals (<<1 mm; amphibole or pyroxene?) in a microcrystalline groundmass. The vesicularity of the clasts varies between almost dense and 15%. This rock appears to be in particular suitable for age dating because of its abundant fresh plagioclase phenocrysts. The

last dredge at this guyot (DR20) has been conducted ~13 km north of DR19 and aimed again to sample its upper slope (Fig. 5.10). The dredge, however, stuck almost at the starting point of the dredge track at 2,790 m b.s.l. and had to be released by the vessel so that the dredge has been dragged only a few meters along the slope (if at all). Nevertheless the dredge contained a Mn-encrusted fragment of a volcanic conglomerate a two highly altered volcanic breccias. The conglomerate is composed of up to some cm-sized sub-angular to rounded lava pebbles which are cemented by white material and manganese. Unfortunately the manganese has penetrated the rock along veins. Two pebbles (DR20-1-A and -B) have been separated. They contain ~5% plagioclase needles (<1 mm) and ~3% pyroxene (<1 mm) in an almost dense, fine-grained, reddish-brownish altered groundmass. The breccia consists of cm-sized brown, red, and gray subangular clasts in a white matrix. The clasts have ~5% plagioclase needles (<1 mm) and up to 20% partly filled vesicles.

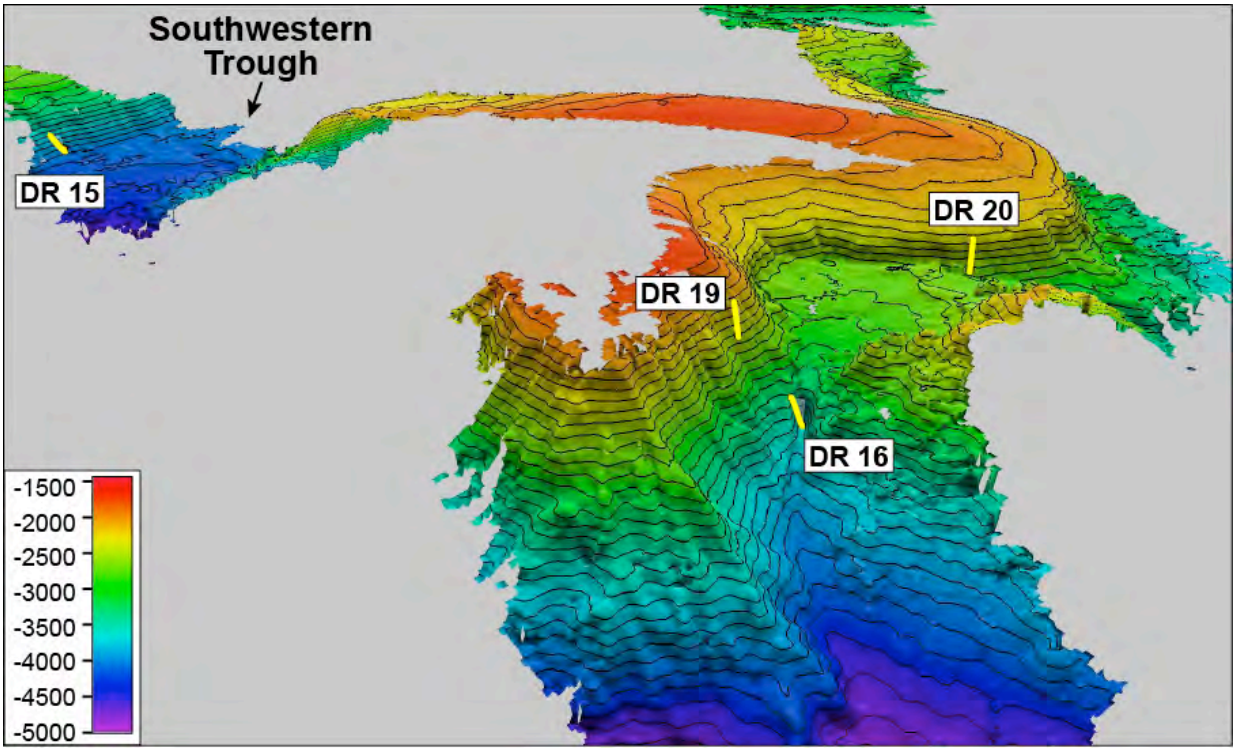

Fig. 5.10: 3D-map showing ship´s tracks crossing the southern section of the narrow central part of Walvis Ridge. SO-233 dredge tracks DR15 - 20 are marked by yellow lines (view from SE to NW). Data source, exaggeration, and contours as in figure 5.4.

Fig. 5.11: A fairly fresh lava fragment dredged from a steep canyon wall at the base of an guyot.

Fig. 5.12: The left picture shows the typical appearance of an altered, Mn-encrusted fragment of a volcanic breccia. Careful preparation of the large brownish lava clast (in front of the left picture) reveals lots of plagioclase phenocrysts suitable for age dating (right picture).

Further to the north, R/V SONNE carried out several dredge stations in-between the two troughs (Fig. 5.9). Most of them aimed to sample the slopes of smaller guyot-like features with top plateaus in 2,100 - 2,300 m water depth (Fig. 5.13). DR21 has been carried out from 2,690 m to 2,400 m b.s.l. at the southern slope of the small guyot and yielded only a small fragment of a coarse-grained clastic sediment and two carbonate crusts. A second dredge (DR23, 2,930 - 2,540 m b.s.l.) at the eastern slope of this guyot was empty. The third attempt DR24 has been conducted from 2,930 m to 2,540 m b.s.l. at the southeastern slope in-between the two previous stations. This dredge recovered one huge block from a fossil coral reef. The carbonate contains many cm-sized, subrounded to subangular, aphyric volcanic rock fragments. They are fine-grained, moderately to highly altered and contain up to 40% partly filled vesicles.

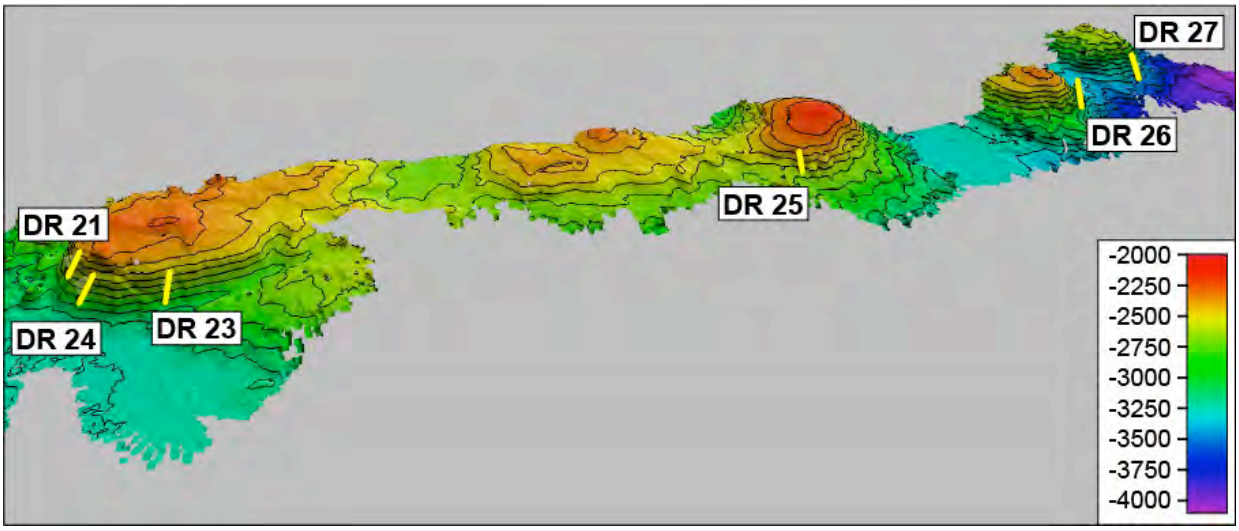

Fig. 5.13: 3D-map showing ship´s tracks crossing various guyots and other features in-between the two trough-like extensional structures. SO-233 dredge tracks DR21 - 27 are marked by yellow lines (view from ESE to WNW). Data source, exaggeration, and contours as in figure 5.4.

Approximately 37 km further north dredge haul DR25 (2,600 m - 2,400 m b.s.l.) aimed for the eastern slope of another small guyot but failed to recover hard rocks (Fig. 5.13). The next attempt (DR26) has been made from 3,200 m to 2,780 m b.s.l. at a small cone-like feature on the northern slope of a third guyot. Unfortunately the dredge again returned empty. Directly to the northwest, DR27 was located at the lower eastern slope of a seamount with a less distinct top plateau. The dredge, however, stuck immediately at the starting point of the dredge track in 3,360 m water depth and had to be untethered by moving the vessel. Nevertheless DR27 yielded two fragments of a altered, Mn-encrusted volcaniclastic rock containing mostly rounded, aphyric lava clasts with completely palagonized glassy rims and ~15% vesicularity in a yellowish-white matrix. Several of the only a few cm-sized clasts have been separated from the sample (DR27-1-A to -D) for further examination and possibly preparation for analyses.

Between 26°10’ and 26°30’S and 2°50’ and 3°30’E is a north-south trending seamount-like structure that is attached to the Walvis Ridge in the south but separated by a deep trough to the east (Fig. 5.14). Where the seamount is attached to the ridge, we mapped a series of inward facing scarps on both sides that suggest normal faulting along an extinct incipient rift system. The eastern side of the seamount and western side of the adjacent Walvis Ridge are very steep to nearly vertical, in any case much steeper than the western side of the seamount. We interpret the steep eastern flank of the seamount to have once been attached to the similar steep flank of the main part of the Walvis Ridge. We further speculate that due to differential extension in the north related to seafloor spreading and breaking off and rifting of the Rio Grand Rise, the seamount was also rifted away forming a pull-apart type basin between itself and the main part of the ridge, that remained hinged to the ridge in the south. The differential extension is consistent with a change in direction of fracture zones from northwest-southeast to primarily east-west further to the west and of the graben-like structures in the south. with increasing distance from the Walvis Ridge. Seven dredge stations have been conducted at the seamount-like structure and its counterpart at the ridge (Fig. 5.14). DR28, 29, and 31 aimed to

sample the steep eastern flank of the seamount. Dredge haul DR28 has been conducted at the lower slope from 4,100 m to 3,900 m b.s.l. and recovered one volcaniclastic rock and three largely aphyric, fine-grained lava fragments which slightly differ in vesicularity, degree of alteration and appearance of groundmass. Sample DR28-1 is a fairly fresh to medium-altered, dense lava with very few 1-2 mm-sized altered reddish phenocrysts in a dark-gray groundmass which shows a glomerophyric texture (feldspar + pyroxene). Sample DR28-2 represents a more altered variety with 20% partly filled vesicles (including up to 5 mm long pipe-like vesicles) in a brownish gray groundmass. Sample DR28-3 is similar to DR28-2 but less vesicular (~3%) and show fresh feldspar needles in its groundmass, which may be suitable for dating after careful preparation.

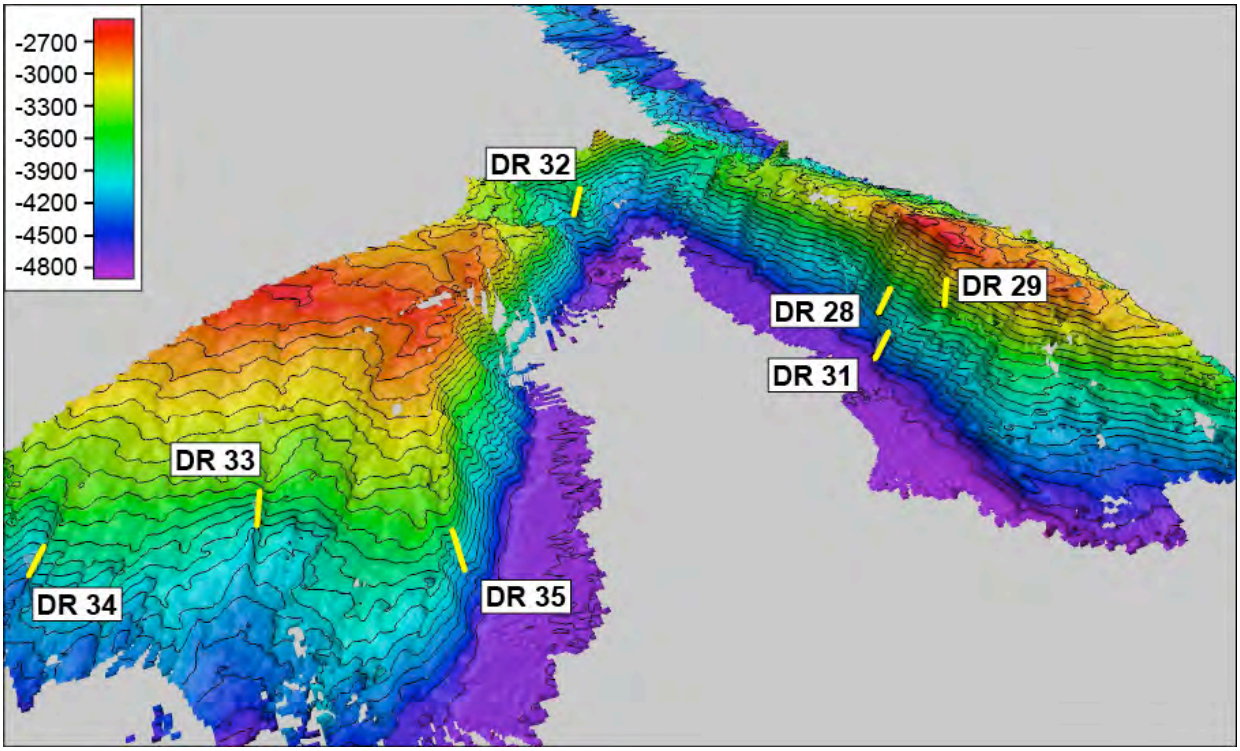

Fig. 5.14: 3D-map showing the north-south trending seamount (on the right) and its counterpart at the ridge margin (on the left) in the northern section of the narrow central part of the Walvis Ridge. We interpret the basin between the two structures as pull-apart basin. Yellow lines mark SO-233 dredge tracks DR28 - 35s (view from NNE to SSW). Data source, exaggeration, and contours as in figure 5.4.

Dredge haul DR29 has been made upslope of DR28 from 3,420 to 3,139 m and yielded four different lithologies of volcanic and sedimentary rocks. The dominating lithology is represented by dense, brownish-gray volcanic rocks (samples DR29-1 to -5). Without thin section examination, it remains unclear if these rocks are dense lava fragments or tuffaceous rocks consisting of ash and mineral fragments. Approximately 5 - 15% small fresh to medium altered feldspars (<1 mm) and ~25% probably altered, sub-mm-sized brownish spots, which could be altered olivine, palagonite, or lithic fragments, are recognizable. Even though if this rock turns out to be a tuff after thin section examination, the feldspar may be suitable for age dating after careful preparation. The second lithology is altered, reddish-brown aphyric lava (DR29-6 to -9). Its fine-grained groundmass contains medium altered interstitial plagioclase and ~25 - 30% round to irregular formed vesicles. Samples DR29-10 to -14 are polymict volcaniclastic rocks consisting of subangular to subrounded lithic clasts in a greenish-yellowish and in places white matrix. Most clasts are similar to the volcanic rocks described above. Finally, dredge DR29 contained a carbonate block similar to those found further south at station DR21. Dredge station DR31 has been conducted downslope of DR28 und 29 and targeted for the base of the slope (4,687 - 4,720 m b.s.l.) but failed to return rocks.

Dredge station DR32 was located from 4,010 m to 4,140 m b.s.l. along the northern slope of a cone-like feature on the flank of the ridge above the southern and of the pull-apart basin (Fig. 5.14). The dredge recovered two moderately altered aphyric lava fragments. The fine-

grained, brownish-gray groundmass of the first fragment contains lots of small groundmass feldspar and ~20% vesicles with ~70% of them filled with calcium carbonate. The second fragment has a more coarse-grained, holocrystalline groundmass with only ~3% filled vesicles.

Fig. 5.15: Pillow fragment recovered by dredge DR 35. Note the largely preserved glass crust.

Fig. 5.16: Fairly fresh, dense interior of a pillow fragment found in dredge DR35.

The next three dredge hauls in this area have been carried out at the northern flank of the ridge (Fig. 5.14). DR33 returned empty from the middle section of the flank. Approximately 8 km further east, dredge haul DR34 recovered a volcaniclastic block out of 4,220 m to 3,820 m water depths b.s.l. from the steep slope of a small canyon. The block has a yellowish surface and contains up to 9 cm-sized, largely homogeneous lava clasts in a completely altered, brownish-greenish to gray matrix. Four of the larger clasts (samples DR34-1-A to -D) and a collection of small clasts (<4 cm; sample DR34-1-X) have been separated for further studies. The lava is only moderately altered, almost dense, and porphyritic with ~15% fresh to slightly altered plagioclase (<5 mm) and ~10% altered greenish phenocrysts of unclear nature in a fine-grained, gray groundmass. The last dredge in that area (DR35), made ~16 km WNW from 4,060 m to 3,700 m b.s.l. (Fig. 5.14), was one of the most successful of cruise SO-233 by recovering ~300 kg volcanic rocks including fresh glass. The majority of these rocks are fresh to moderately altered pillow fragments with partly preserved glassy rims (Fig. 5.15). The lava is porphyritic, dense to slightly vesicular and contains ~10% up to 5 mm-sized fresh plagioclase and ~1% up to 2 mm-sized iddingsitized olivine phenocrysts in a gray, fine-grained groundmass (Fig. 5.16). Samples DR35-1 to -13 represent this pillow lava and some varieties with slightly higher or lower amounts of plagioclase and olivine phenocrysts and/or a more coarse-grained groundmass (feldspar, pyroxene). Samples DR35-14 and -15 are an almost aphyric variety of the pillows whereas DR35-16 and -17 do not contain olivine phenocrysts and are more altered. Minor lithologies in dredge DR35 are two types of volcaniclastic rocks. Sample DR35-18 is a brownish tuffaceous rock, which appears to consist of small minerals, lithic fragments and ash. Sample DR35-19 is a volcanic breccia consisting of angular fragments of the pillow lavas described above in a fine-grained, yellowish-greenish matrix. This breccia may represent the talus in-between the pillow tubes or in front of the pillow lava flow sampled by DR35.

5.2.3 The Broad Central Part of Walvis Ridge (DR37 - 64)

Major Morphological Features

The broad central part of the Walvis Ridge extends from ~27° to 23°S (Fig. 5.17). Its central area consists of a large plateau-like structure (Valdivia Bank) located largely at depths

shallower than ~2,000 m with dimensions of ~200 km in the north-south direction and ~100 km in the east-west direction. We believe that the plateau was formed through erosion of a large volcanic island to sea level as it subsided.

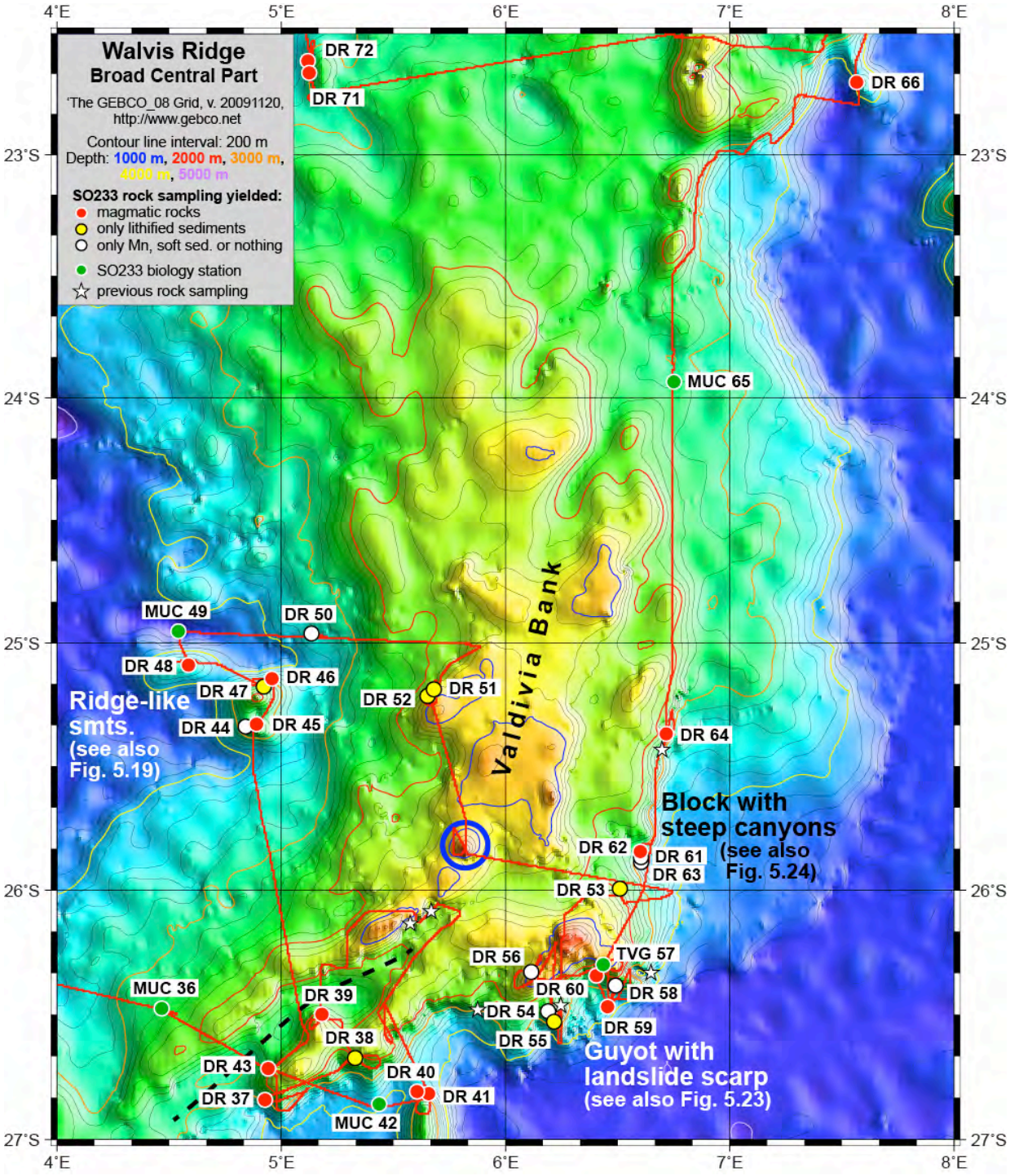

Fig. 5.17: Overview map of the broad central part of the Walvis Ridge (based on "The GEBCO_08 Grid, version 20091120", http://www.gebco.net). Major morphological features discussed in this chapter are annotated. The black dashed line shows the axis of a prominent graben structure cutting into the southern end of Valdivia Bank (see also Fig. 5.18). The blue circle in the southern section of the Valdivia Bank marks the area in which a large seamount is displayed by the predicted bathymetry (and in nautical maps) whose existence could not be confirmed by SO-233 multi-beam mapping (see also Fig. 5.22). Dots mark SO-233 sampling stations, stars previous rock sampling stations, and red lines the SO-233 ship´s track. Note that station DR66 - DR72 belong morphologically to the northeastern part of Walvis Ridge and are described in the next chapter.

Cutting the southern portion of Valdivia Bank is an impressive northeast-southwest trending graben extending roughly from 27°15'S, 4°00´E to 25°55', 6°30'E possibly for almost 200 km in length with widths reaching almost 20 km (Figs. 5.17, 5.18). The steep walls on both sides of the graben are up to 1,000 m high. The southwestern ~140 km of the graben are roughly parallel with the northwestern margin of the Walvis Ridge in this area. The northeast-southwest striking part of the northwestern side of the Walvis Ridge is bound to the north and south by roughly NNW-SSE trending margins to the ridge that extend to the northwest, looking like a box-shaped piece that was taken out of the ridge. We interpret the graben structure and the morphology of the northwestern Walvis margin to reflect extension related to NNW-directed spreading, with the NNW-SSE margins representing the terminations of fracture zones that change their strike to east-west further to the northwest, similar to the trough-like structures further south, which we also believe reflect the terminations of extended fracture zones. Since the northeast-southwest oriented graben disrupts the normal dome shape of the erosional platform, we believe that the graben postdates the erosion to sea level. The graben, however, must have at least begun to form directly after or during the final stages of erosion, because we recovered reef carbonates from one of the graben walls by dredging (see below), which were likely to have formed in the photic zone (upper c. 200 m b.s.l.). Finally, this and the southern part of the Walvis Ridge were once adjacent to the southern half of the Rio Grande Rise, as becomes clear when tracing fracture zones across the southern Atlantic to the margin of the Rio Grande Rise.

Additional evidence for large-scale extensional tectonic movements comes from the eastern side of the central part of the Walvis Ridge. A large block (≤100 km in the north-south direction by ≤40 km in the east-west direction) with a relatively flat erosional surface is located at ~3 km depth, thus ~1 km deeper than other such surfaces in this region (Fig. 5.17). On the eastern edge of this block, we mapped very steep canyons with nearly vertical sides (Fig. 5.24) that we believe could only have formed as submarine canyons just below sea level at the margin of an ocean island. We interpret a steep scarp on the western side of the block, separating it from an erosional platform further to the west located at only ~2 km depth, as a normal fault. We believe that the block was down-dropped ~1 km after its erosion to wave base level, similar to the large graben structure further south (discussed above). The steep scarp on the eastern margin of the block into which the canyons were eroded could also reflect the scarp of a normal fault with the region further to the east being subsided another ~1 km. Both normal faults and the graben structure were most likely related to the rifting apart of the Walvis and Rio Grande Rises by the mid Atlantic Ridge.

On the southeastern flank of the broad central part of the Walvis Ridge sits a large guyot (Figs. 5.17, 5.23) reaching depths of <700 m (the shallowest portion of the guyot was not mapped). A ~30 km wide embayment is located between what may represent two rift arms of the large guyot (former shield volcano) that extend to the southeast and southwest. The steep headwall of the embayment and the many chaotic blocks at the base and to the south of the embayment are consistent with a massive submarine slide, triggered by activity along the rift arms, that have formed this embayment.

Finally, between 25°35'S and 25°00´S and 4°30'E and 5°00´E, we mapped and sampled three ridge-like seamounts with very even and steep slopes that strike fromN70° to N90°E (Figs. 5.17, 5.19). These seamounts, located west of the Walvis Ridge, are arranged roughly perpendicular to the spreading direction and we believe that they represent volcanism along extensional cracks perpendicular to the spreading direction and the orientation of the transform faults.

Rock Sampling

Rock sampling in the broad central part of Walvis Ridge started in the area of the southwest-northeast trending graben (DR39 and 43), the southeastern ridge margin (DR37 and 38) and at a neighboring seamount off the ridge (DR40 and 41) (Fig. 5.18). Dredge track DR37 was located mid-slope at the flank of the ridge in 3,160 - 2,720 m water depth. The dredge recovered just one piece of altered volcanic breccia consisting of up to 9 cm-sized angular to rounded brownish lava clasts in a white matrix. Two clasts (samples DR37-1-A and -B) have been separated from the breccia. These are highly altered porphyritic lavas with at least 20% partly fresh, up to 8 mm-sized plagioclase and ~1% altered olivine phenocrysts in a very fine-grained, homogeneous brownish groundmass. Many plagioclase phenocrysts show

zonations and host inclusions. The second attempt to sample the flank of the ridge (DR38) was placed ~40 km further northeast at the upper section of the flank from 2,600 m to 2,170 m b.s.l. but yielded only fragments of a carbonatic breccia and micritic limestone.

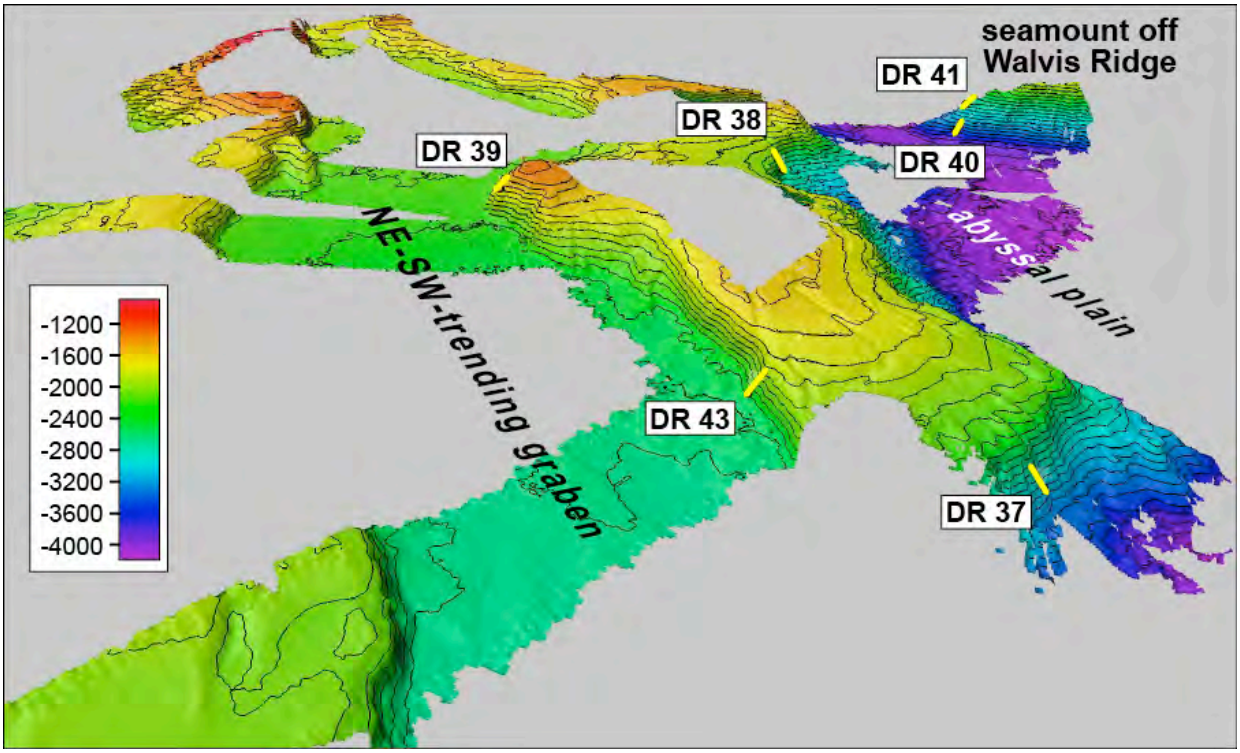

Fig. 5.18: 3D-map showing ship´s tracks crossing the prominent graben structure in the southeastern section of the broad central part of the Walvis Ridge and the adjacent ridge margin. SO-233 dredge tracks DR37 - 43 are marked by yellow lines (view from WSW to ENE). Data source, exaggeration, and contours as in figure 5.4.

Dredge haul DR39 was made at the southeastern wall of the prominent graben (Fig. 5.18) from 2,090 m to 1,830 m b.s.l. The dredge returned half full with lava fragments, volcaniclastic rocks, and carbonates from which altogether 29 samples have been taken. The majority of the samples (DR29-1 to -23) are aphyric, fine-grained lava fragments. The lava varies in degree of alteration from almost fresh to highly altered and in vesicularity from dense to vesicular with >20% vesicles which are partly filled. Some of the less altered samples show fresh groundmass feldspar, which may be suitable for Ar/Ar dating. The second major lithology found in dredge DR39 are various carbonate blocks showing bioturbation, which most likely represent relicts of a fossil reef. Minor lithologies are a greenish, altered volcaniclastic rock, which contains small (<1.5 mm) angular clasts in a fine-grained matrix and a completely altered polymict lapillistone. A second dredge haul (DR43) has been conducted ~32 km further southwest at the graben wall from 2,440 m to 2,000 m b.s.l. This dredge contained 10 lava clasts comprising five different lithologies. The first lithology (DR43-1 and -2) is a porphyritic lava with ~15% completely altered olivine (up to 1 cm, partly replaced by calcite), ~2% clinopyroxene (<4 mm) and partly fresh plagioclase needles in a fine-grained grayish groundmass with ~10% vesicles. Samples DR43-3 and -4 are also porphyritic but have 15% up to 12 mm-sized fresh to moderately altered plagioclase and only ~2% up to 3 mm-sized altered olivine phenocrysts in a very fine-grained, gray to brown groundmass with 10% mostly open vesicles. Samples DR43-5 through -8 are less vesicular (0 - 7%) and less porphyritic (~1 - 10% plagioclase and ~1 - 5% altered olivine) and show a grayish, largely fresh and fine-grained groundmass. Sample DR43-9 is a throughout altered, reddish lava penetrated by calcite (?) veins. Finally, an altered light brown lava with ~5% plagioclase phenocrysts (<3 mm) and ~10% partly filled, elongated vesicles in a fine-grained homogeneous groundmass has been sampled as DR43-10.

Dredge station DR40 targeted the lower northern slope from 3,580 m to 3,260 m b.s.l. of a north-south elongated seamount located on the abyssal plain south of the southeastern flank

of the ridge (Figs. 5.17, 5.18). The dredge returned one big pillow lava block and some large boulders of fine-grained yellowish sediment. The moderately altered pillow lava has a very fine-grained, brownish-gray groundmass which contains ~40% sub-mm-sized plagioclase microphenocrysts. The margins of the pillow are dense but its interior has ~20% round and elongated vesicles measuring up to some centimeter in length or diameter. Dredge track DR41 was located ~5 km east of DR40 at the same seamount at its upper slope from 2,930 m to 2,660 m b.s.l. and recovered Mn-encrusted lava fragments, carbonates representing fragments of a fossil coral reef, and a massive Mn-crust. The medium to highly altered porphyritic lava is vesicular (up to 30% partly filled vesicles) and contains ~10% altered olivine and ~5% mm-sized plagioclase phenocrysts in a fine-grained gray to brownish groundmass.

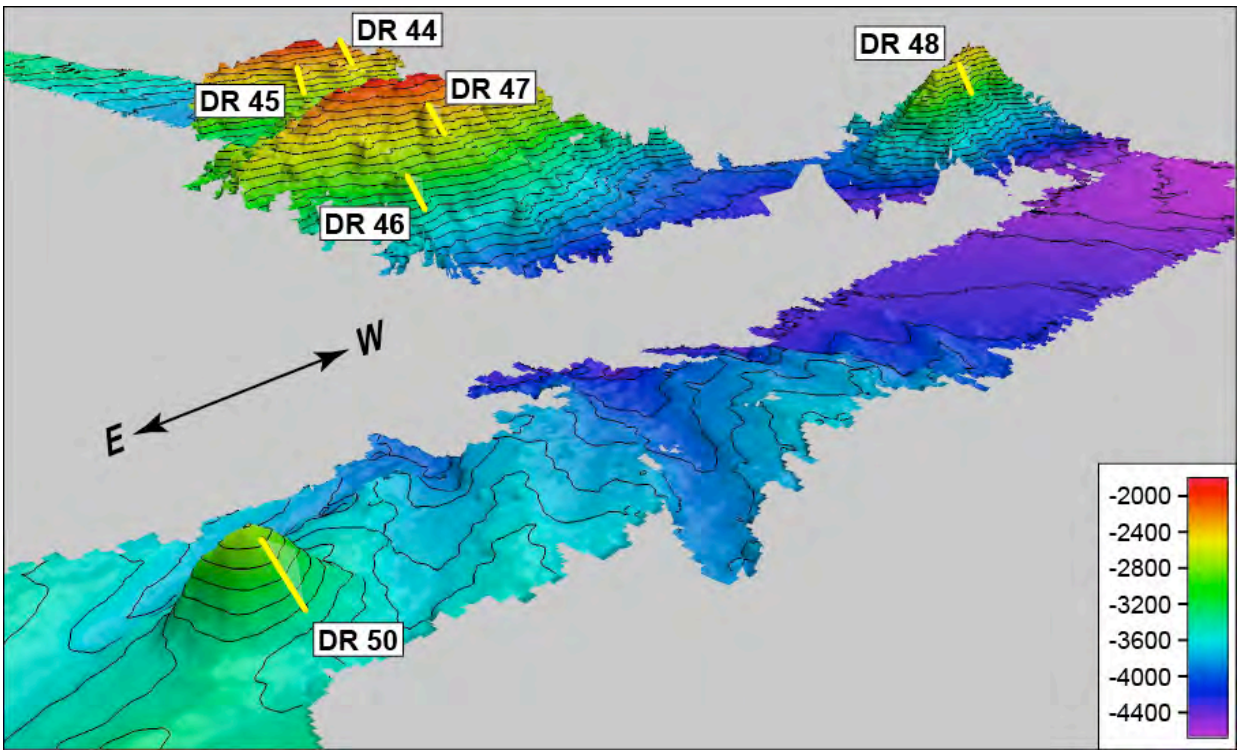

Fig. 5.19: 3D-map showing ship´s tracks crossing the three approximately east-west striking ridge-like seamounts off the western margin of the broad central part of the Walvis Ridge (cf. Fig. 5.17). SO-233 dredge tracks DR44 - 50 are marked by yellow lines (view from NE to SW). Data source, exaggeration, and contours as in figure 5.4.

The next target of cruise SO-233 were the three elongated, roughly east-west striking seamounts located south of 25°S off the western margin of the Walvis Ridge (Figs. 5.17, 5.19). The first dredge (DR44) executed at the upper northern slope of the southernmost ridge failed to return rocks. Dredge haul DR45 has been conducted downslope at the same ridge ~4.5 km southeast of DR44 from 2,580 m to 2,180 m b.s.l. at the front of a small shoulder emanating from the main edifice to the north. This dredge yielded a few lava clasts (Fig. 5.20), a volcaniclastic rock, massive Mn-crusts, and fragments of a fossil coral reef (Fig. 5.21). The lava is moderately altered with a fairly fresh gray interior turning into more altered yellowish-brownish zone at the margin and has palagonized glassy rims at their surface. Their texture is slightly porphyritic with ~3% altered olivine phenocrysts (<3 mm) in a fine-grained groundmass which contains 30% mm-sized, mostly filled vesicles. The volcaniclastic rock is a fragment of a polymict breccia or lapillistone with multicolored, up to 4 mm sized clasts in an unsorted matrix. Some of the clasts have been separated on board but appear too small and altered for further analytics.

Dredge hauls DR46 and 47 aimed to sample the northern flank of the central ridge (Fig. 5.19). DR46 has been carried out along the lower slope from 3,310 m to 2,890 m b.s.l. and returned one Mn-encrusted lava pebble and three blocks of solidified, yellowish-white pelagic sediment. The lava is porphyritic with 15% completely altered olivine (<15 mm), 5% pyroxene (<3 mm) and a few small feldspar phenocrysts in a highly vesicular (~30%), brownish altered

groundmass. Dredge track DR47 has been placed up-slope from 2,540 m to 2,160 m b.s.l. ~4.5 km southwest of DR46 but recovered only one Mn-encrusted carbonate bloc.

Fig. 5.20: Lava fragment dredged at one of the ridge like seamounts off the western margin of the Walvis Ridge.

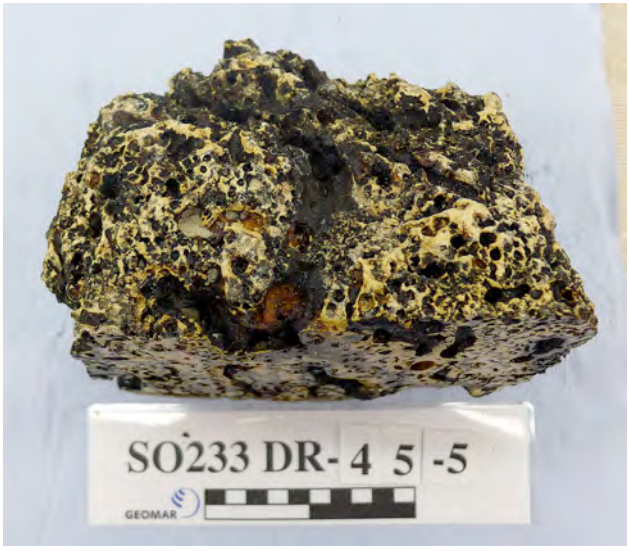

Fig. 5.21: Typical bioturbated carbonate as it occurs frequently in the area of the Walvis Ridge. These carbonates most likely represent relicts of fossil coral reefs.

By contrast, dredge DR48, carried out at the northern ridge directly beneath its crest from 2,979 m to 2,520 m b.s.l. (Fig. 5.19), returned half full with volcaniclastic blocks and carbonates. The volcaniclastic rocks represent a monomict breccia with plenty of cm- and dm-sized, moderately to highly altered lava clasts in a fine-grained, white matrix. The lava is porphyritic and vesicular with ~20-30% mm-sized vesicles, approximately half of them filled with calcite, manganese or chalcedone. The phenocryst assemblage comprises ~10% plagioclase needles (<1 mm), ~2% altered olivine (<5 mm), and ~1 - 2% clinopyroxene (<5 mm). The groundmass of the larger clasts appears gray and fairly fresh in their interior. Some clasts have palagonitized glassy rims. Five of the larger clasts (samples DR48-1 through -5) have been separated for further examination and preparation. The heavily bioturbated carbonates found in this dredge are interpreted as fragments of a fossil reef.

On the way back the Walvis Ridge, we discovered a small, ~600 m high volcanic cone, measuring ~3 km in diameter at its base, directly at the toe of the margin of the Walvis Ridge (Fig. 5.19). Dredge haul DR50 aimed to sample this feature along its northern slope from 3,324 m to 2,900 m b.s.l. but recovered only one small piece of a throughout altered, brownish to reddish sedimentary rock of unclear provenance.

Close to the axes of the broad central part of the Walvis Ridge, SO-233 made two attempts to sample the western flank of the Valdivia Bank (Figs. 5.17, 5.22). Dredge track DR51 was placed right beneath the plateau edge from 1,540 m to 1,210 m b.s.l. and close-by dredge DR52 sampled the middle section of the same slope. Both dredges, however, yielded, apart from one Mn-crust, exclusively carbonates and fossil corals. Therefore we came to the conclusion, that the upper part of the Valdivia Bank, at least in this area, is formed by fossil coral reefs and did not made further dredge attempts. Our next target was a large seamount displayed by the predicted bathymetry (Fig. 5.17) and on nautical maps in the southern section of the Valdivia Bank. Multi-beam mapping, however, revealed just plain ocean floor in that area and therefore proved that this seamount does not exist (Fig. 5.22).

Afterwards, SO-233 rock sampling focused on the huge guyot on the southeastern flank of the broad central part of the Walvis Ridge (Fig. 5.23). This guyot is oval shaped, measures ~80 x 45 km at its base, and its erosional plateau is located between ~1,100 m to less than 700 m b.s.l. Its most remarkable feature is a prominent landslide scarp in its southeastern slope. The first dredge DR53 has been conducted at its northern slope from 2,160 m to 1,990 m b.s.l. and yielded only silty sediments with thick Mn-crusts.

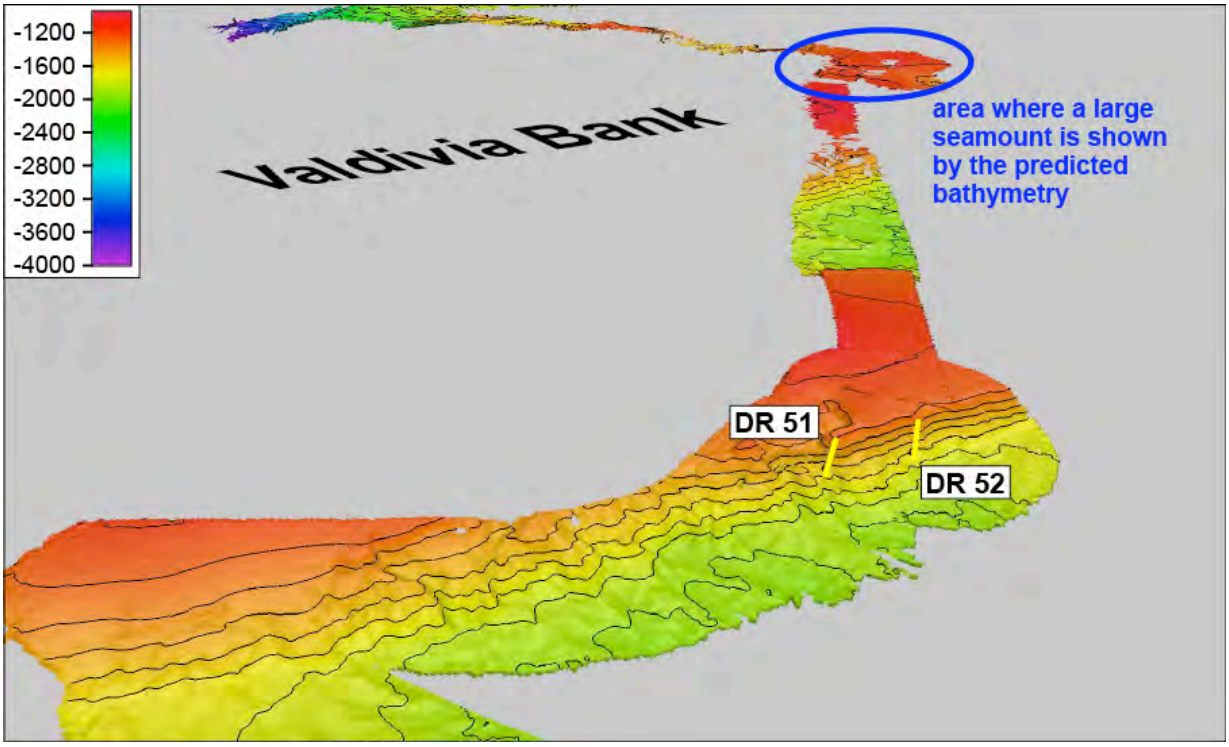

Fig. 5.22: 3D-map showing ship´s tracks crossing the Valdivia Bank in the middle of the broad central part of the Walvis Ridge. A large seamount rising up to less than 200 m below sea level, is shown by the predicted bathymetry and on nautical maps in the blue encircled area (cf. Fig. 5.17). SO-233 multi-beam mapping revealed that this feature does not exist. SO-233 dredge tracks DR51 and -52 made at the western flank of Valdivia Bank are marked by yellow lines (view from WNW to ESE). Data source, exaggeration, and contours as in figure 5.4.

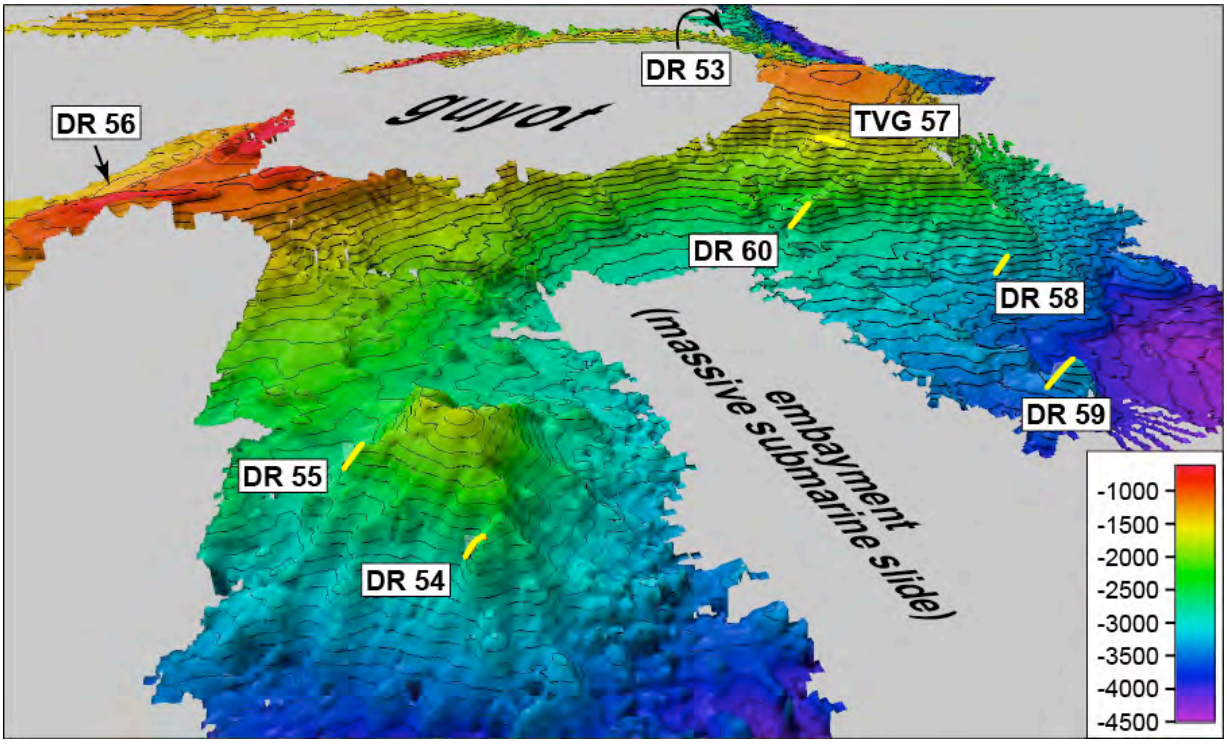

Fig. 5.23: 3D-map showing the large guyot the southeastern flank of broad central part of the Walvis Ridge (cf. Fig. 5.17). Note the prominent landslide scarp at the southeastern slope of the guyot. SO-233 dredge tracks DR54 and -55, -58 through -60, and TV-grab station TVG57 are marked by yellow lines; the position of dredge tracks DR53 and -56 (not visible on this map's perspective) are indicated by arrows (view from SSW to NNE). Data source, exaggeration, and contours as in figure 5.4.

Dredge hauls DR54 and -55 aimed to sample a seamount-like feature off the steep headwall of the landside scarp, which may represent a huge displaced block (Fig. 5.23). Unfortunately DR54 failed to return rocks from the northwestern slope of this feature. Dredge haul DR55 recovered only Mn-encrusted carbonates out of 2,460 m to 2,170 m b.s.l. from its southern slope.

Dredge DR56 executed along the upper northwestern slope of the huge guyot was again empty. Afterwards R/V SONNE returned to the area of the landslide scarp. Surprisingly the TV-grab yielded the first magmatic samples from this area. TVG57 has been conducted at the upper part of the northeastern flank of the scarp in 1,520 m to 1,670 m b.s.l. (Fig. 5.23). Apart from sandy soft sediments, the grab contained a few lava fragments and volcaniclastic rocks. The largest lava clast (sample TVG57-1;17x11x11cm) is moderately to strongly altered and contains up to 3% altered olivine phenocrysts and black minerals in a fine-grained brownish to reddish groundmass with ~5% partly calcium carbonate-filled vesicles. Among the smaller clasts is a completely altered, aphyric, and highly vesicular (40%) variety (sampleTVG57-2) and a small piece (sample TVG57-7; 5x5x3 cm) of comparatively fresh, porphyritic, and dense lava which contains altered olivine and pyroxene phenocrysts and white needles (feldspar?). The volcaniclastic rocks comprise completely altered polymict breccias and lapillistones with multicolored clasts in a reddish-brownish or yellowish matrix. Dredge station DR58 targeted the base of the same flank of the scarp ~10 km southeast of the TV-grab station but failed to return rocks.

Dredge track DR59 was placed along the western slope of a small cone-like feature off the embayment (Fig. 5.23). The cone measures 2.5 km in diameter at its base, is ~450 m high, and may represent a displaced block from the guyot. DR59 returned a lava clast and a carbonate bloc from 3,530 m to 3,090 m b.s.l. The lava is porhyritic, and highly vesicular with > 50% mostly filled vesicles in a fine-grained, relatively fresh gray groundmass. The phenocrysts assemblage comprises ~15 pyroxene (<3 mm), 10% olivine (<2 mm), and 5% plagioclase (<2 mm) which are all completely altered. Finally, DR60 was executed at the lower section of the main guyot flank from 2,530 m to 2,230 m b.s.l. right beneath the TV-grab station. The dredge contained gray to black, highly vesicular lava fragments with ~45% mostly filled vesicles and ~15% up to 7mm-sized altered olivine phenocrysts in a fine-grained, dark groundmass.

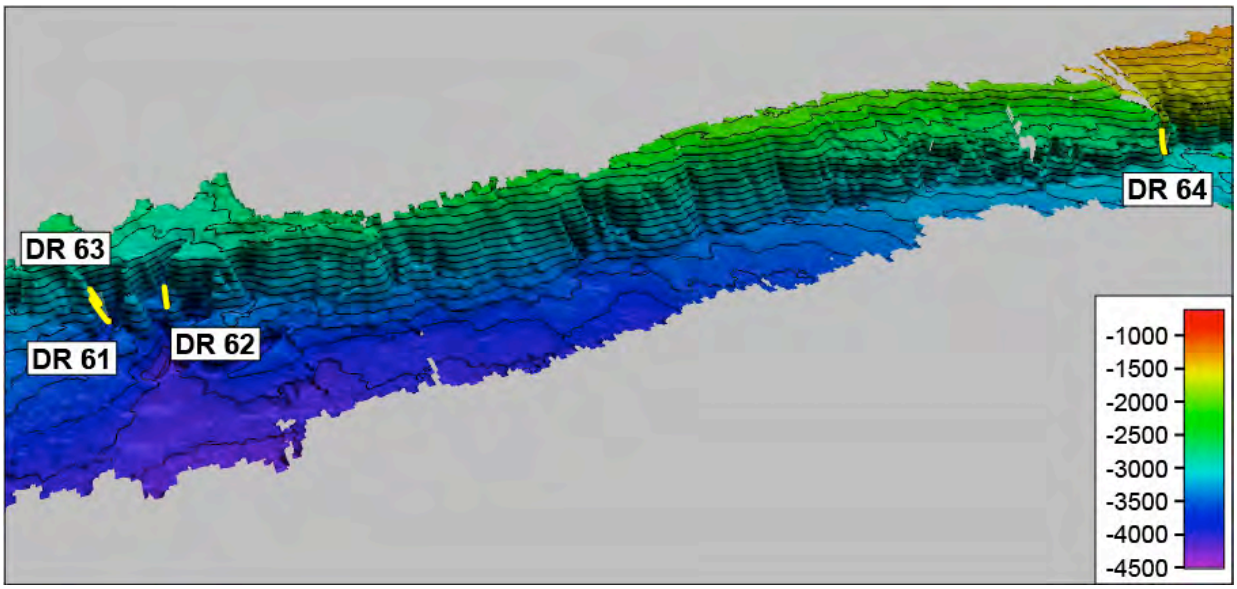

Fig. 5.24: 3D-map showing the eastern flank of the large block forming the eastern part of Valdivia Bank (cf. Fig. 5.17). Note the very steep canyons with nearly vertical sides cutting into the flank. SO-233 dredge tracks DR61 through -64 are marked by yellow lines (view from ESE to WNW). Data source, exaggeration, and contours as in figure 5.4.

Upon completion of the work at the huge guyot and the landslide scarp, R/V SONNE sailed to the north along the eastern flank of the block forming the eastern part of the Valdivia Bank (Fig. 5.24). Remarkably, very steep canyons with almost vertical slopes cut into the block. Dredge hauls DR61 through -63 aimed to sample the slopes of these canyons. Dredge track

DR61 was placed at the base of the southern slope inside one of these canyons but the dredge stuck directly at the beginning of the track and had to be freed by moving the vessel. Accordingly, DR 61 failed to return samples. DR62 was then conducted ~2.5 km further north at the base of the northern slope of another canyon from 3,770 m to 3,680 m b.s.l. This dredge was quite successful by returning two rocks with fresh material suitable for geochemical analyses and age dating. The first sample (DR62-1; Fig. 5.25) is a fairly fresh, almost dense porphyritic lava with 1-2% plagioclase needles, 1-2% black pyroxene needles, and 1% olivine in a fine-grained gray groundmass. All (micro) phenocrysts measure < 1 mm and, except of the olivine, are fresh. The second sample (DR62-2; Fig. 5.26) is a lapillistone (or hyaloclastite) with 2 cm-sized glassy particles in a dense fine-grained glassy matrix. Surprisingly, the glass is partly preserved and can be separated for analyses. The outer parts of the glassy particles, however, are palagonitized so that careful preparation is required. This rock also contains lots of small (<1 mm) plagioclase needles. Dredge DR63 has been carried out directly above the failed dredge haul DR61 and was the second try to sample this site but failed again to sample rocks. About 57 km further north, dredge haul DR64 aimed to sample the base of the flank of a block directly south of a small canyon (Fig. 5.24). The dredge returned some lava clasts from 2,930 m to 2,720 m b.s.l. The moderately altered, almost dense lava is penetrated by calcium carbonate-filled veins and shows a porphyritic texture with 10% altered and replaced olivine (<3 mm), ~7% <1 mm long plagioclase needles, and ~5% clinopyroxene (<1 mm) in a very fine-grained, brownish to grayish groundmass. Careful examination of thin sections is required to evaluate if the plagioclase is fresh and suitable for age dating.

Fig. 5.25: Fresh lava dredged from the wall of a canyon cutting into the block east of Valdivia Bank.

Fig. 5.26: Lapillistone consisting of glassy particles in a fine-grained matrix. Notably fresh glass is preserved in some of the particles.

5.2.4 The Northern Part of Walvis Ridge (DR66 - 90)

The northern part of Walvis Ridge extends from ~23°00´S to ~18°00´S. Here the strike of the ridge axis rotates from north-south at the transition to the broad central part of the ridge to WSW - ENE close to the base of the Namibian continental shelf (cf. Fig. 4.16) where the Walvis Ridge is connected to the Etendeka flood basalts.

On the southeastern side of this part of the Walvis Ridge at ~22°30'S, ~7°30'E, we mapped a guyot volcano with a top plateau between ~1,800 and 1,600 m b.s.l. and a base at about 2,600 m b.s.l. (Figs. 5.27, 5.28). Two ≤40 km rift arms radiate to the northeast and SSE. This volcano is likely to have belonged to the initial formational stage of the Walvis Ridge and sampling was therefore of particular importance. Dredge track DR66 has been placed at the upper western slope of the SSE rift arm from 3,870 m to 3,550 m b.s.l. and recovered fairly fresh lava fragments and a few volcaniclastic rocks. The fine-grained gray groundmass of the lava is formed by fresh plagioclase and pyroxene minerals and contains ~2 - 3% up to 5 mm-sized olivine phenocrysts and ~7 - 15% partly filled vesicles (mm to sub-mm range). The groundmass appears to be suitable for geochemical analyses and age dating. The volcaniclastic rocks consist of heavily altered highly vesicular lapilli and possibly bubble wall shards in a fine-grained yellowish matrix and may be pyroclastic in origin. Unfortunately, the

attempt to sample the northwestern flank of the guyot (DR67) resulted in the loss of the dredge.

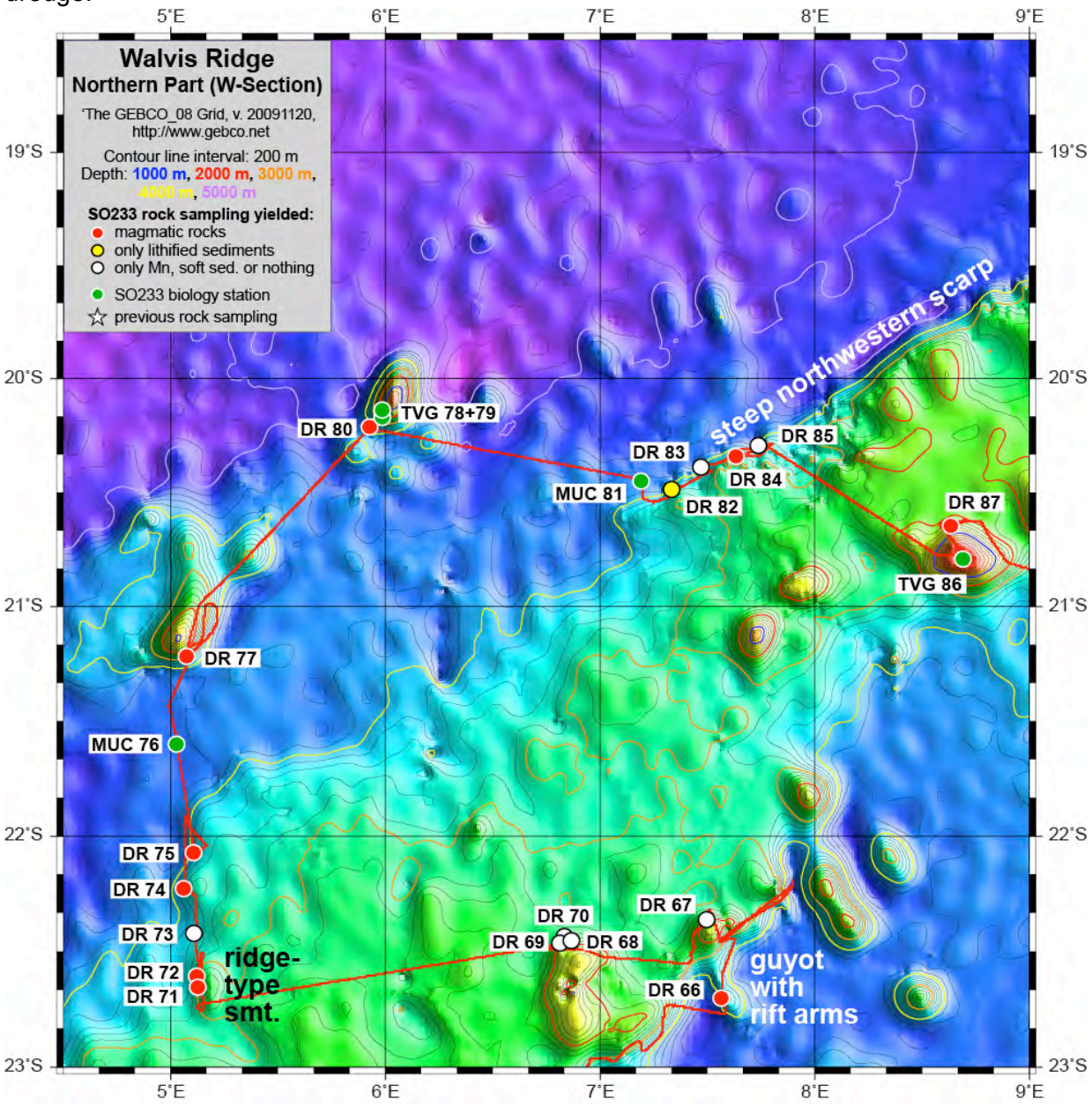

Fig. 5.27: Overview map of the western section of the northern part of the Walvis Ridge (based on "The GEBCO_08 Grid, version 20091120", http://www.gebco.net). For the eastern section see figure 5.37. Dots mark SO-233 sampling stations and red lines the SO-233 ship´s track. Mapping and sampling of the features located to the southeast and northeast of the guyot with the rift arms has been conducted on the follow-up cruise SO-234/1 (see Werner and Wagner, 2014).

Due west, R/V SONNE mapped parts of a guyot on the main ridge (Fig. 5.28) with an erosional top between 1,800 - 1,400 m b.s.l. and with a possible late-stage (post-erosional) cone extending to <1,300 m b.s.l. The base of this guyot is at about 2,600 m b.s.l. similar to the guyot described above. Unfortunately, all three sampling attempts at this guyot failed to recover magmatic rocks. Dredge DR68 returned empty, dredge haul DR69 yielded only a few carbonate crusts most likely representing relicts of a fossil coral reef, and dredge DR70 returned empty again.

On the western side of the southern section of the northern Walvis Ridge between 22°30' and 22°50'S and 5°10'E is a ridge-type seamount located on the edge of the plateau with a steep scarp on it's western side and an erosional top between ~2,500 m and 2,100 m b.s.l. and its base on the ridge side being at ~2,900 m b.s.l. (Figs. 5.28, 5.29). We interpret this seamount to have formed along an extensional fault after the formation of the Walvis Ridge

and Rio Grande Rise but before both ridges rifted apart. It's deeper erosional top and base suggests more subsidence on the western than southeast side of the Walvis Ridge, despite its late development at the end of the ridge formation. The greater subsidence and tilting of the Walvis Ridge to the west no doubt is related to the presence of the mid-Atlantic Ridge on its western side.

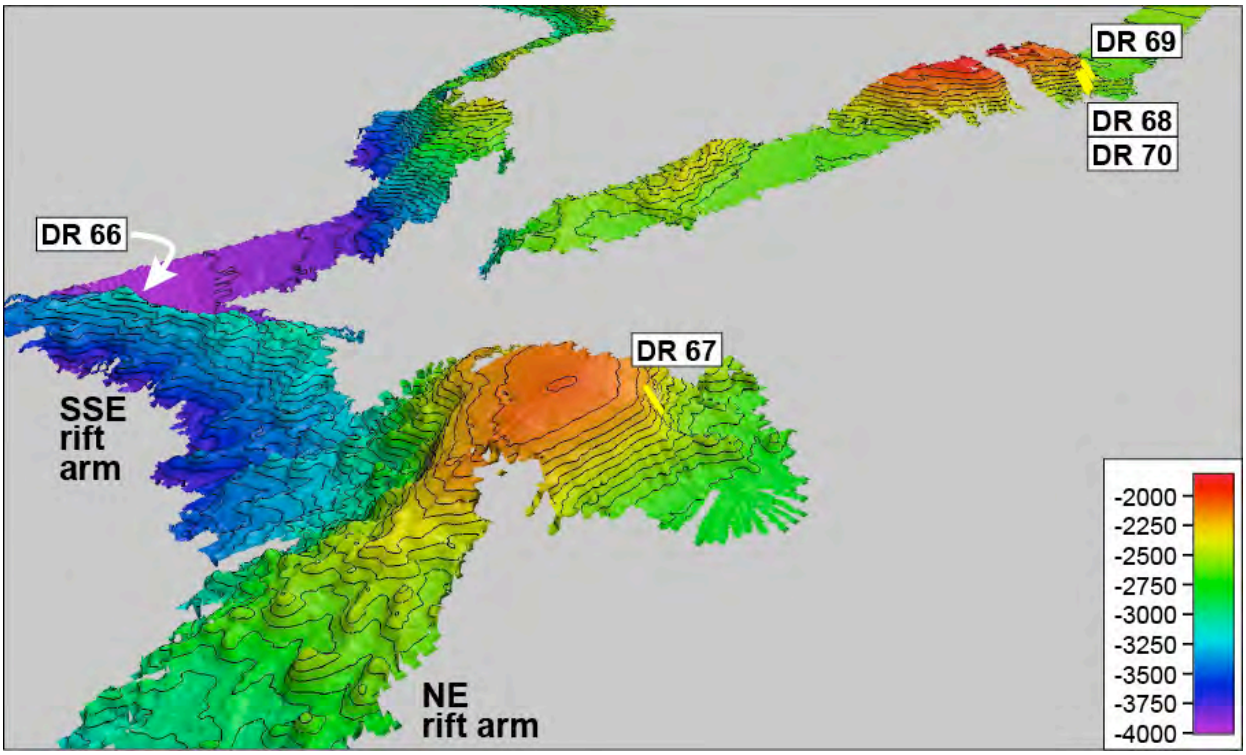

Fig. 5.28: 3D-map showing ship´s tracks at the southeastern flank of northern part of the Walvis Ridge (cf. Fig. 5.27). Note the prominent guyot with the two SSE and NE striking rift arms in the center of the map. SO-233 dredge tracks DR67 through -70 are marked by yellow lines; the position of dredge track DR66 (not visible on this map's perspective) is indicated by an arrow (view from NE to SW). Data source, exaggeration, and contours as in figure 5.4.

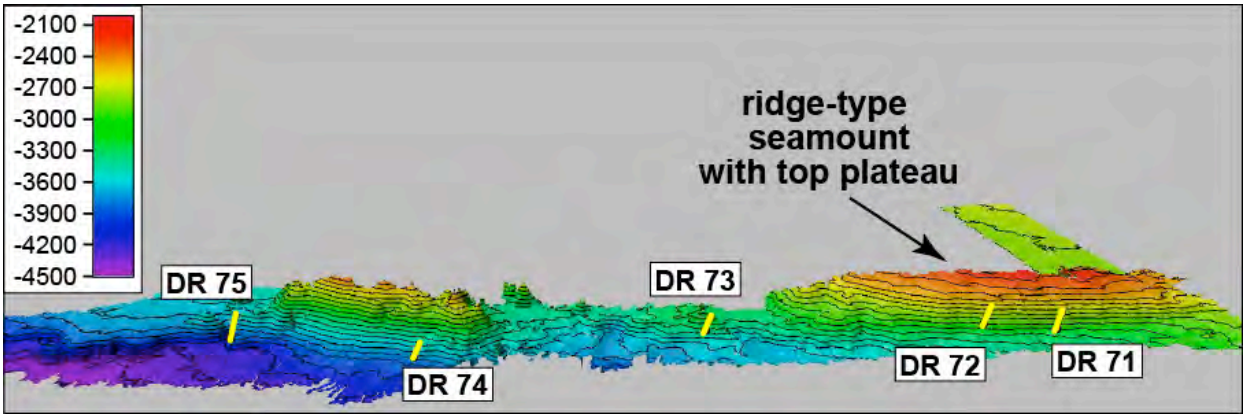

Fig. 5.29: 3D-map showing the ship´s track along the southern section of the western margin of the northern part of the Walvis Ridge (cf. Fig. 5.27). SO-233 dredge tracks DR71 through -75 are marked by yellow lines (view from WSW to ENE). Data source, exaggeration, and contours as in figure 5.4.

Two dredge stations have been carried out at the steep western slope of this ridge-type seamount (Fig. 5.29). Dredge haul DR71 aimed to sample the lower western flank of the seamount from 3,120 m to 2,980 m b.s.l. and yielded two rocks. Sample DR71-1 is a highly altered, brownish lava fragment with ~7% altered olivine (<3 mm) and <1% pyroxene (<1 mm) in a fine-grained groundmass with 5% filled vesicles. The groundmass, however, contains ~50% small plagioclase needles. If thin section evaluation reveals that the groundmass plagioclase is fresh it may be suitable for age dating. The second sample DR71-2 is a highly

altered volcaniclastic rock consisting of reddish, mm- to cm-sized highly vesicular lava clasts in a yellowish matrix. Dredge station DR72 was made ~5 km further north at the middle section of the western slope from 3,020 m to 2,690 m b.s.l.. This dredge recovered only one highly altered volcaniclastic rock with clasts similar to those found in sample DR71-2 embedded in an white calcitic matrix.

The next three dredge stations DR73 to -75 targeted the western flank of Walvis Ridge north of the ridge type seamount (Fig. 5.29). Dredge haul DR73 was conducted at the northwestern slope of a small cone-like structure located on the ridge flank but returned empty. Dredge track DR74 was located at the base of the western flank from 3,800 m to 3,580 m b.s.l. right beneath the southern end of a seamount located on the ridge margin and yielded only one small, highly altered orange-brown lava fragment with pervasive manganese infiltrations along veins and fractures. The lava is porphyritic with ~20% mm-sized olivine phenocrysts which are completely replaced by secondary minerals. The fine- to medium-grained groundmass is dense and appears to be dominated by feldspar. At this stage it is not clear if the feldspar in the fresher parts of the rock may be suitable for analytics. The last dredge in this area (DR75) was conducted from 4,110 m to 3,580 m b.s.l. directly north of the seamount along the southern slope of a steep canyon cutting into the ridge flank. In contrast to the previous dredge hauls, which yielded only very few rocks for unknown reasons, this dredge returned almost half full with volcanic rocks. Two lithologies dominate among them. The first major lithology (Fig. 5.30; samples DR75-1 through -5) is a fairly fresh, aphyric pillow lava with varying vesicularity (~15 - 50% mostly filled vesicles). The gray groundmass is fine-grained and contains fresh plagioclase needles and some altered olivine. The second major lithology (Fig. 5.31; samples DR75-6 through -11) is characterized by some kind of peperitic structure. The rocks consist of mingled pillow-like lava fragments, which partly show palagonitized glassy rims. The lava is moderately altered and has up to 50% partly filled vesicles (<2 mm). Their grayish to brownish, plagioclase and possibly pyroxene-bearing groundmass is fine-grained and contains up to ~7% altered, mm-sized olivine phenocrysts. Minor lithologies include a highly altered, probably polymict volcanic breccia consisting of unsorted lava clasts and lapilli in a light matrix and a completely altered volcaniclastic rock whose fine-grained yellowish matrix (altered volcanic ash?) contains tiny black spots (minerals?) and very few lava fragments up to 3 cm in size.

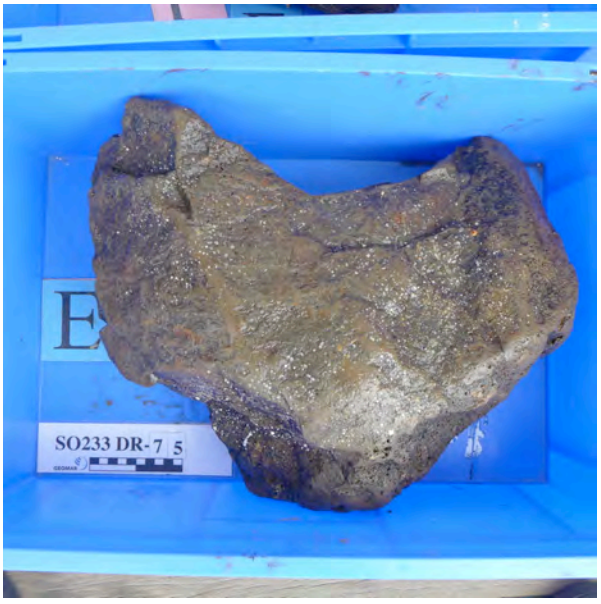

Fig. 5.30: Large pillow fragment dredged at a canyon cutting into the western flank of Walvis Ridge.

Fig. 5.31: Mingled lava fragments dredged from the same canyon as the pillow lava shown in figure 5.30. These rocks may have formed when lava intrudes into wet sediments.

A north-south oriented seamount, due north of the previous ridge-type seamount on the Walvis Ridge margin, is located about 50 km from the Walvis Ridge (Fig. 5.32). It's similar

orientation to the seamount on the western ridge margin suggests that it was also formed along an extensional fault or crack related to spreading along the mid-Atlantic Ridge. This seamount has an erosional plateau at depths between 2,500 m and 2,100 m b.s.l. similar to the ridge-type seamount on the Walvis margin described above. Dredge station DR77 has been conducted at the middle section of the southwestern slope of that seamount from 3,270 m to 2,970 m b.s.l. The dredge yielded moderately to highly altered angular pillow fragments with palagonitized glass rims. The lava is aphyric, fine-grained and highly vesicular with ~30% partly filled vesicles measuring mostly <2 mm. Parts of the pillows rims are only "semi-altered" and may still contain spots where fresh glass is preserved. Such "semi-altered" rims have been collected as sample DR77-1-A in order to evaluate in the home labs if fresh glass can be separated for analyses. The interior of the fresher pillow lava fragments (samples 77-1 and -2) is gray and appears to be fairly unaltered.

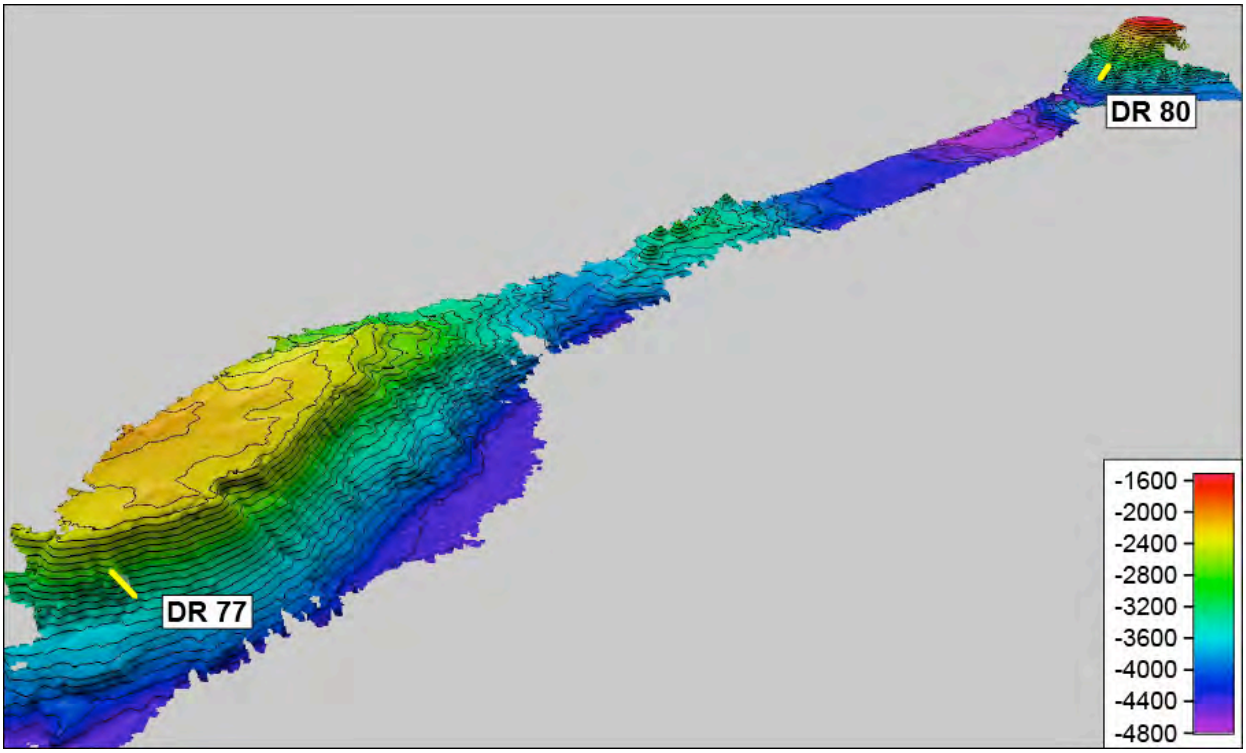

Fig. 5.32: 3D-map showing a ship´s tracks across the two guyot-type seamounts located ~50 km north of the northwestern margin of the Walvis Ridge (cf. Fig. 5.27). SO-233 dredge tracks DR77 and -80 are marked by yellow lines (view from S to N). Data source, exaggeration, and contours as in figure 5.4.

A further seamount to the northeast at ~20°00´S, 6°00´E has a north-east orientation and a plateau between 1,800 m and <1,600 m b.s.l., which is shallower than seen at the previous seamounts (Fig. 5.32). Sampling of that seamount has been carried out along the upper slope of a volcanic cone located at its southwestern slope toe. Dredge DR80 delivered a few lava fragments comprising two lithologies. One is fairly fresh lava with a fine-grained groundmass containing ~20% plagioclase microphenocrysts (<1 mm) and prominent elongated pipe vesicles which are partly filled with calcium carbonate and zeolites. The other lithology is a heavily altered, orange-brownish porphyritic lava with ~10% completely altered olivine phenocrysts and ~35% vesicularity. Notably, this lava shows irregular dark schlieren which consist of fresher material as the surrounding orange-brown groundmass.

The northwest margin of the Walvis Ridge between 7°00´ and 11°00´E has a very steep scarp (Fig. 5.33, see also Fig. 5.38) that matches up (following transform faults) with a southeast facing scarp of equal length off the Brazilian coast. It's orientation is similar to nearby transform faults in the ocean basin suggesting that this scarp is a result of a left lateral transform fault as well. Four dredge attempts have been made at the southwestern end of this steep scarp (Fig. 5.33). Dredge haul DR82 was conducted close to the southwestern termination of the scarp at the lower slope from 4,720 m to 4,210 m b.s.l. but yielded only lots of unconsolidated to slightly consolidated fine-grained clayey sediments (pelite).

Approximately 17 km further northeast, dredge DR 83 returned empty from the base of the scarp. Again ~17 km further northeast, we discovered a canyon-like embayment cutting into the scarp which may represent a slumping structure. Dredge station DR84 was located from 3,790 m to 3,410 m b.s.l. along the upper eastern slope of this embayment (Fig. 5.33). This dredge finally recovered magmatic rocks besides yellow sediments and chert. The rocks comprise moderately to highly altered, dense and porphyritic lava fragments with ~20 - 35% altered plagioclase phenocrysts up to 10 mm in size and ~3 - 5% black or reddish-brown minerals of yet unclear nature. The fine-grained, grayish to brownish groundmass of the freshest sample (DR84-1) contains many feldspar needles, which appear fresh and may be suitable for age dating. The last dredge haul in that area (DR85) has been made ~11 km further northeast at the lower eastern slope of another embayment right beneath a small seamount but failed to return samples.

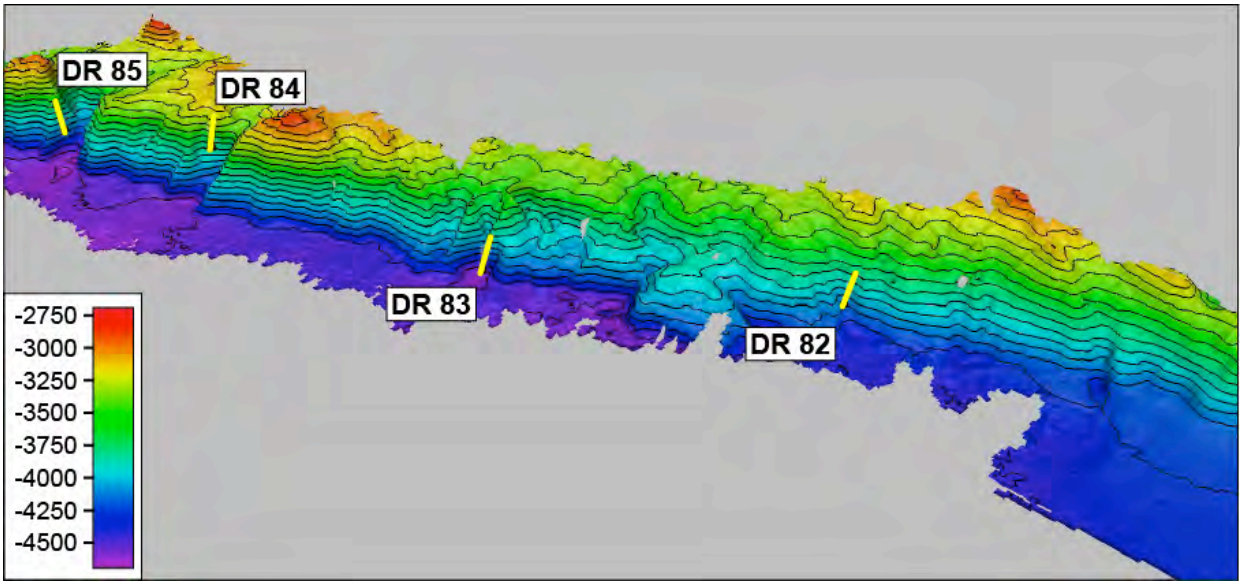

Fig. 5.33: 3D-map showing a ship´s track along the southwestern end of the steep scarp at the northwestern margin of the Walvis Ridge (cf. Fig. 5.27). SO-233 dredge tracks DR82 through -85 are marked by yellow lines (view from NW to SE). Data source, exaggeration, and contours as in figure 5.4.

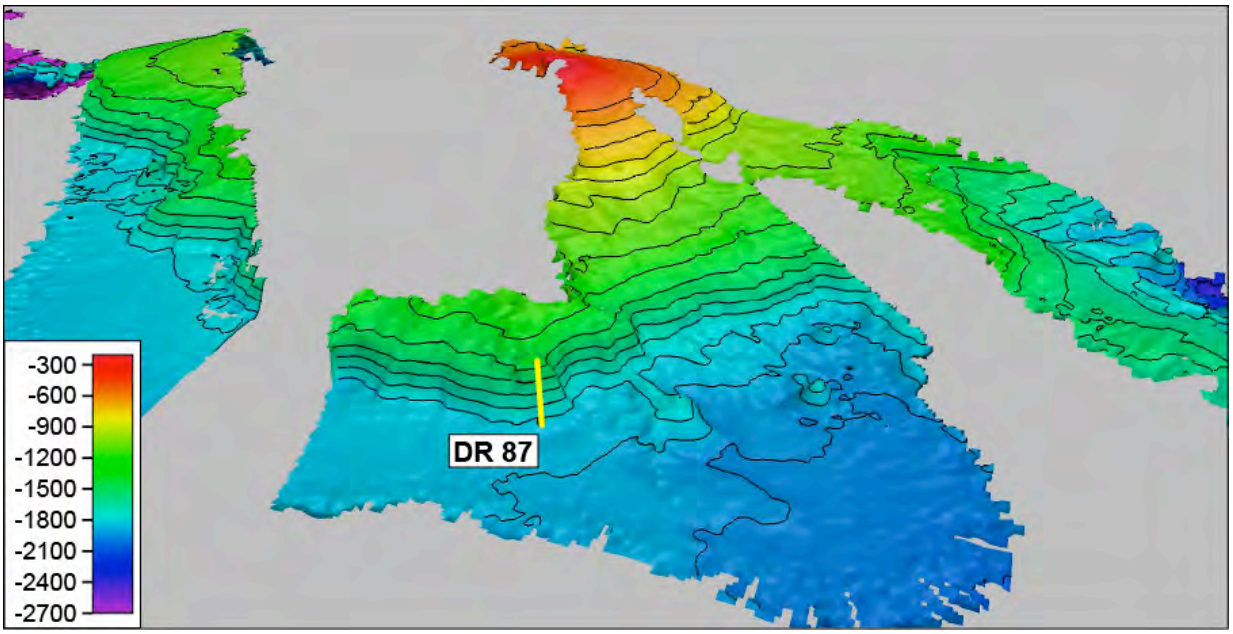

Fig. 5.34: 3D-map showing a ship´s tracks across a guyot-type seamount on the southeastern margin of the Walvis Ridge (cf. Figs. 5.27 and 5.37). SO-233 dredge track DR87 is marked by a yellow line (view from NNW to SSE). Data source, exaggeration, and contours as in figure 5.4.

The next target of SO-233 rock sampling was a large guyot-type seamount situated on the southern margin of the northwestern part of the Walvis Ridge (Figs. 5.34, 5.37). The guyot is roughly oval-shaped and measures ~42 km in east-west direction at its base. Its erosional plateau is located between ~1,300 to 1,000 m depths. On the western part of the plateau a younger, post-erosional volcanic feature forms a secondary guyot with a top between ~500 and 300 m, indicating at least two phases of volcanic activity. Dredge station DR87 has been conducted along a steep step at the northwestern slope of the main edifice of the guyot from 1,840 m to 1,330 m b.s.l. (Fig. 5.34). The dredge returned more than half full and contained a broad variety of lavas, volcaniclastic rocks, Mn-crusts, yellowish sediments, and biological material, among them at least four different lithologies of volcanic rocks. The first lithology (samples DR87-1 and -2) is a moderately altered, almost dense lava with less than 1% vesicles. The fine-grained, brownish-gray groundmass contains various amounts (1 - 15%) of well-preserved plagioclase phenocrysts being up to 3 mm in size. Whereas the plagioclase appears to be well suitable for age dating, preparation for geochemical analyses requires careful picking since manganese migrates like dendrites from veins into the fresh rock. A 40x30x20 cm-sized bloc of a volcanic breccia represents the second lithology (sample 87-3, Fig. 5.35). The breccia consists of 2 - 10 cm-sized lava clasts, which are cemented by pelagic sediment and manganese. The brownish-gray, moderately altered lava clasts have a very dense texture and contain ~3% plagioclase phenocrysts in a fine-grained groundmass. Basically the lava clasts are very similar to the first lithology from this dredge (samples DR87-1 and -2) and the breccia may represent the top or flow-foot breccia of the DR87-1 and -2 lava flow. The third lithology (sample DR87-4) is also similar to the two previously described lavas but these absolutely dense, reddish-brown lava appears to be more altered and contains only feldspar microphenocrysts. Samples DR87-5 through -12 are greenish and reddish heavily altered porphyritic lava fragments. They contain up to ~20% feldspar phenocrysts (< 5 mm) in a fine-grained, dense groundmass (Fig. 5.36). Whereas the groundmass is completely altered and probably not appropriate for analyses, the feldspar in some samples (e.g. DR87-5 to -7) is fresh and most likely suitable for age dating. Further rocks in that dredge include completely altered red lava fragments (sample DR87-13) and a volcanic breccia consisting of relatively well preserved, dense and aphyric lava clasts in a white to brownish fine-grained matrix (sample DR87-14).

Fig. 5.35: Large block of a volcanic breccia dredged from a guyot-type seamount on the southern margin of the Walvis Ridge.

Fig. 5.36: Lava fragment from the same guyot. Note that the heavily altered groundmass contains lots of well-preserved feldspar phenocrysts.

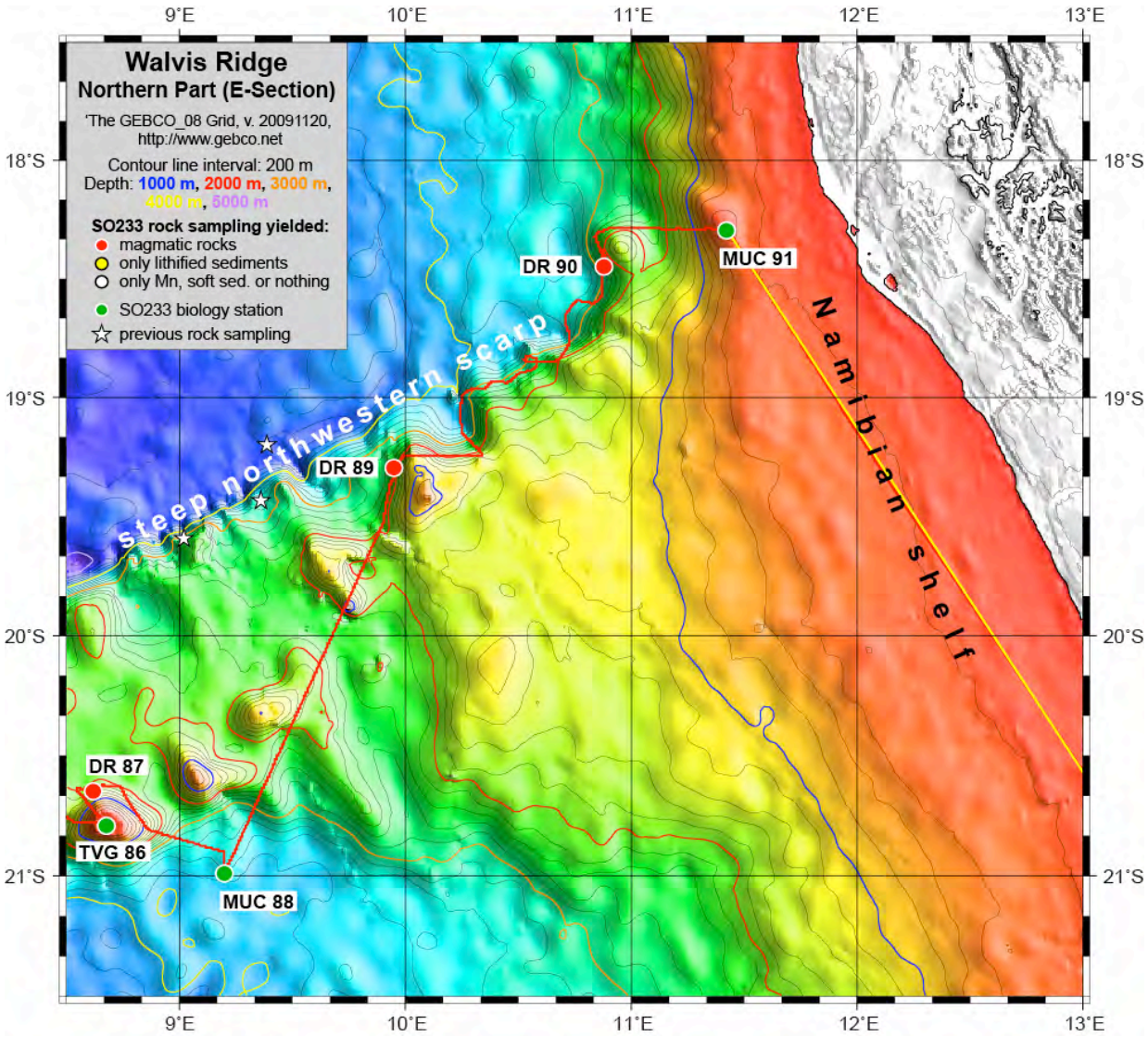

Fig. 5.37: Overview map of the eastern section of the northern part of the Walvis Ridge (based on "The GEBCO_08 Grid, version 20091120", http://www.gebco.net). For the western section see figure 5.27. Dots mark SO-233 sampling stations, red and yellow lines the SO-233 ship´s track.

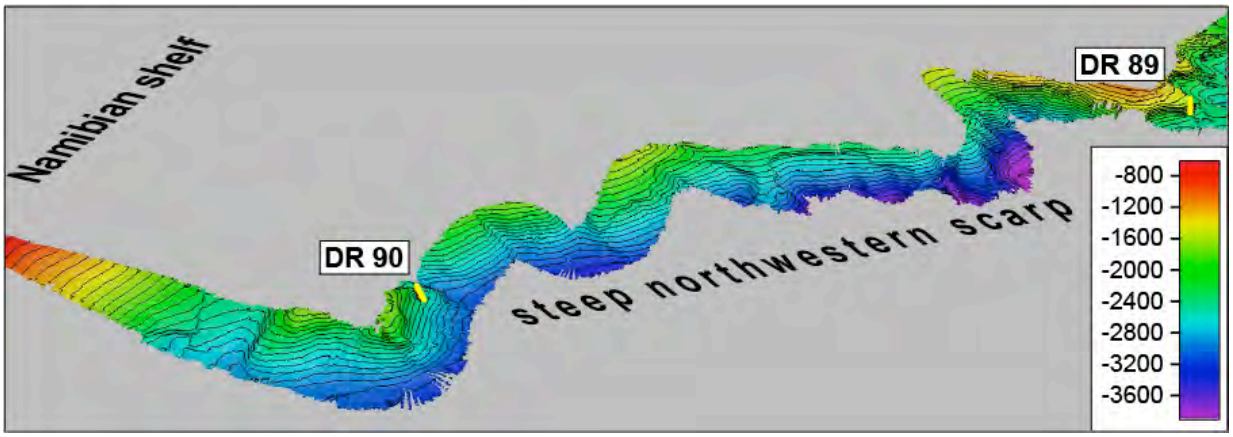

Fig. 5.38: 3D-map showing a ship´s track along the northeastern part of the steep scarp at the northwestern margin of the Walvis Ridge (cf. Fig. 5.37). SO-233 dredge tracks DR89 and -90 are marked by yellow lines (view from NNW to SSE). Data source, exaggeration, and contours as in figure 5.4.

After completion of the investigation at the large guyot, R/V SONNE returned to the steep scarp at the northwestern margin of the Walvis Ridge (Figs. 5.37, 5.38). Dredge station DR89 has been carried out at the upper northwestern slope of a large guyot situated on the scarp

from 2,000 m to 1,620 m b.s.l. (Fig. 5.38). The dredge haul yielded various lava fragments comprising four lithologies and volcaniclastic rocks. Samples DR89-1 through -4 are fairly fresh porphyritic lava clasts with less than 5% calcium carbonate-filled vesicles. The lava contains each ~5 - 10% altered olivine (up to 1,5 cm), quite fresh black pyroxene (up to 8 mm), and fresh feldspar phenocrysts (up to 5 mm) in a fine grained, gray groundmass with visible plagioclase and olivine minerals, the latter are altered to iddingsite. The second lithology (sample DR89-5 and -6) are aphyric, dense lava fragments. The largely fresh groundmass is fine-grained and contains fresh feldspar and iddingsitized olivine. Some veins filled with phyllosilicates penetrate the rocks. Sample DR89-7 represents the third lithology. This rock is also aphyric but more vesicular with ~15 - 20% partly calcium carbonate-filled vesicles. Some fairly fresh feldspar minerals are visible in the very fine-grained groundmass. The lava shows fresh gray parts and more altered reddish parts. Notably the reddish parts are more vesicular than the gray areas. The fourth lithology (samples DR89-8 and -9) are fresh, highly vesicular lavas with ~60% mostly open, partly pipe-like vesicles which measure up to 1.5 cm. The dark gray groundmass of this lava is fine-grained and does not show any macroscopically visible minerals. Apart from the lavas, DR89 recovered some fragments of a volcanic breccia. The breccia consists of grayish, brownish, and yellowish to whitish angular lava clasts in a very fine-grained grayish matrix. The clasts are mm- to cm-sized, dense, aphyric and fine-grained. Some of them contain little feldspar and light-gray clay (?) minerals. This breccia may be monomict and could have been formed by an explosive hydroclastic eruption.

Fig. 5.39: Fairly fresh, porphyritic lava sampled from the steep scarp at the northwestern margin of Walvis Ridge (cf. Fig. 5.38).

Fig. 5.40: Monomict (?) breccia, which may have been formed by explosive hydroclastic eruptions.

Finally a small, ~1,500 m high seamount measuring ~28 km in diameter was sampled to the northwest of the northeastern termination of the steep scarp, directly at the base of the Namibia continental shelf, and most likely post-dates any movement along the northeast end of the fault. Dredge track DR90 was located along a small "noose" at the upper southwestern slope of this seamount from 2,340 m to 1,620 m b.s.l. (Fig. 5.38) and yielded a variety of lava fragments. The dominating lithology is a fairly fresh, porphyritic lava with up to 10% mm-sized, largely open vesicles (samples DR90-1 through -5 and -11 to -15). The rocks consist of a gray, very fine-grained groundmass with some visible feldspar minerals and up to 13% 1 - 3 mm-sized altered olivine phenocrysts. Samples DR90-6 through -10 appear to be varieties of this lithology which are more vesicular (up to 30%) and/or show less olivine phenocrysts (~1 - 7%) and/or contain pyroxene (?) phenocrysts and/or are more altered. Most of these samples have many fractures, which are filled with calcium carbonate or manganese. Sample DR90-6 appears to be completely brecciated.

6. BIOLOGY

(F. de Arnal, N. Furchheim, C. Lüter, F. Matz, A. Nauendorf)

6.1. METHODS

6.1.1 Shipboard Collecting Procedures

Biological material was collected by deployment of (1) a geological chain bag dredge, (2) a TV-grab (TVG) and (3) a TV-multi-corer (TV-MUC). All boulders and rocks collected with the dredge were scanned for encrusting benthic invertebrates. Additionally, four sediment trap tubes (length: 21 cm, diameter: 4 cm) were fixed in the dredge to collect a disturbed sediment sample from each dredging site. Fifteen so-called biological stations were identified using maps of predicted bathymetry by Smith and Sandwell (1997) and Gebco data sets ('The GEBCO_08 Grid, version 20091120, http://www.gebco.net'), in order to collect undisturbed sediment samples and the inhabiting meiofaunal community with the TV-MUC as well as macrofaunal/meiofaunal communities with the TVG. The sites were carefully chosen using PARASOUND and SIMRAD EM 120 profiling to avoid damaging the TV-MUC on hard grounds. The camera of the TV-MUC allowed for proper positioning on soft bottom seafloor. Additionally, via TVG's and TV-MUC's video recording macrofauna observation (planktonic and benthic) on the way down to the sea bed and directed sampling were made possible. The TVG was also used for collecting boulders with encrusting macrofauna and coarse sediments at 6 stations. The video sequences recorded showed rich planktonic and also benthic communities. All video sequences were recorded using two shipboard LG HDD/DVD recorders (b/w and colour) and subsequently transferred on harddrives for analysis of the sediment/rock structure and the nature of the recorded deep-sea plankton and benthos.

At almost all of the 10 successful TV-MUC stations, O_2-concentration of the water trapped in one tube was measured with a multi-parameter measuring device WTW Multi 340i immediately after recovery on deck. Within 12 hours, also pH and salinity were measured in the samples (Table 6.1). Sensors used were WTW CellOx325, WTW SenTix 20 and WTW TetraCon 325. Due to initial problems with the salinity sensor, we had to rely on an old refractometer, which is calibrated to room temperature, hence the high data in the beginning.

6.1.2 Meiofauna

Sediment sampled by the four sediment trap tubes inside the geological chain bag dredges was fixed immediately in cold 6% formaldehyde buffered with buffer tablets for haematology (Merck # 1.09468.10100, pH 7.2). After at least one day of fixation at 4 - 8°C, the formalin was decanted through a 40 µm mesh size sieve and replaced by tap water. The sediment was mixed with the water and allowed to settle for another 24 hrs. The sediment was then washed with plenty of tap water on a 40 µm-sieve and centrifuged (THERMO Heraeus Multifuge 3s) three times for 5 minutes with three to four times the amount of Levasil 200A/40% at 4,000 rpm in order to quantitatively extract the meiofauna. After rinsing with tap water on a 40 µm-sieve, specimens were stored in 75% ethanol. Sediment was sampled with the TV-MUC and TV-grab together with macrofaunal specimens whenever possible. The entire haul from the TV-MUC and TV-grab was carefully checked for additional macrofaunal organisms buried in deeper layers of the sediment. From the TV-MUC, only the upper 5 cm of sediment in each core (inner core diameter: 9.5 cm) were taken. Most of the sediment of the upper 5 cm layer was fixed in cold 6% formaldehyde and processed as described above. About 100 g of sediment from the surface were dried on glass petri dishes in an oven at 60° C for about 2 - 4 days and stored in plastic bags for later analysis of TOCs (= total organic carbon), TC (total carbon) and grain size.

6.1.3 Macrofauna

All macrofauna identifiable either by naked eye or under a dissecting scope in the geology lab onboard R/V SONNE was picked using clean scalpel blades and immediately fixed in 100% ethanol, 4% formalin, 4% paraformaldehyde, 2.5% glutardialdehyde or Bouin's solution, depending on the planned investigation method. Dead shells or skeletons of e.g. brachiopods,

molluscs and corals were air-dried and sealed in plastic bags. All collected living specimens were sorted (phylum level) and separately stored in small vials.

6.2 PRELIMINARY RESULTS AND DISCUSSION

6.2.1 General Observations and Collecting Report

Salinity, pH, and O_2 were in the same range over all 13 TV-MUC stations at both the deeper plains and on the Walvis Ridge except the shallowest shelf station (422 m depth) near the Namibian coast, which was O_2 depleted.(Table 6.1). Due to initial technical probems with the salinity/conductivity sensor, we had to rely on an old optical refractometer, which revealed too high a salinity possibly due to significant temperature differences between the calibration data of the refractometer and the ambient sea water temperature in the deep sea. From plankton observation in both TV-grab and TV-MUC alone, we expect an increase in organic carbon in the sediment from southwest to northeast along the Walvis Ridge. The nearer to the continental shelf of Namibia the more numerous and diverse were the plankton communities in the water column. This may reflect the nutrient transport through the northbound Benguela current and the upwelling of deep water, both of which are expected to be more intense near the African mainland.

Table 6.1: Measurements of several parameters in water column trapped by multi-corer tube.

Station	Date	depth	Salinity [‰]	pH	O_2 [%]
TV-MUC 1	18.5.2014	4,879 m	47.0[1]	n.a.	56.0
TV-MUC 14[2]	24.5.2014	3,083 m	n.a.	n.a.	n.a.
TV-MUC 17	25.5.2014	4,850 m	40.0[1]	n.a.	48.8
TV-MUC 22[3]	26.5.2014	3,179 m	n.a	n.a.	n.a.
TV-MUC 30	28.5.2014	4,722 m	n.a.	n.a.	n.a.
TV-MUC 36	30.5.2014	2,531 m	33.9	7.27	46.0
TV-MUC 42	1.6.2014	4,044 m	33.6	8.0	46.6
TV-MUC 49[3]	3.6.2014	4,655 m	n.a	n.a.	n.a.
TV-MUC 65	8.6.2014	2,861 m	33.9	7.81	40.6
TV-MUC 76	13.6.2014	4,463 m	33.4	7.80	40.5
TV-MUC 81	15.6.2014	4,346 m	33.3	7.78	40.3
TV-MUC 88	17.6.2014	3.856 m	33.8	7.8	38.5
TV-MUC 91	18.6.2014	422 m	33.9	7.67	13.7

[1] with optical refractometer, unreliable data due to ∂T between seawater and calibration
[2] MUC closed on the way down, due to swell-related uplift
[3] bottom water washed out on the way up

Seventy-eight kilogram of sediment from both the sediment traps in the geological chain bag dredges and the multi-corer tubes were fixed in formalin and subsequently processed for meiofauna extraction.

Macrofaunal organisms were recovered at 44 out of 91 collecting stations (36 geological dredges, 5 TVGs and 3 TV-MUCs); 80 stations revealed sediment samples (69 sediment traps, 1 TVG and 10 TV-MUCs). For a detailed list of the collected taxa and the number of specimens per taxon see Appendix III.

6.2.2 Meiofauna

Since the PI responsible for meiofaunal investigation, Birger Neuhaus, could not attend the cruise due to sudden health problems, the samples were only processed to a stage at which

detailed examination and identification under a stereomicroscope would have been possible. As it needs special knowledge on these organisms to properly scan the samples, the latter had to be postponed until the samples were back in the Museum für Naturkunde, Berlin. After arrival of the sea freight container in mid August 2014 and material transfer to the Museum, the samples containing meiofauna were started to be checked.

6.2.3 Macrofauna

As already outlined in our weekly reports of the cruise, the number of macrofaunal organisms collected from dredged rock are surprisingly low. Especially brachiopods were expected to occur in much larger quantities. However, some 90 specimens of living brachiopods representing at least 6 genera were collected and could be preserved for DNA extraction and morphological investigation. Additionally, 2 TV-grab stations revealed many shells of dead brachiopods representing 5 species, one of which with Antarctic origin. Some of these shells were complete, so that species identification is possible. Among the living specimens were many representatives of *Eucalathis*, a standard deep sea brachiopod with a worldwide distribution. These specimens are very useful for a comparison with *Eucalathis* collected on the Agulhas Ridge during cruise MSM 19/3 to test for conspecifics and species distribution. As has been shown by Mau (2014, unpublished), *Eucalathis* sp. in the East Pacific is morphologically variable, but according to molecular analyses represents only one species over a large geographic scale.

The remaining macrofauna was largely composed of sponges, octocorals, some deep water hexacorals, molluscs, polychaetes, bryozoans, cirriped crustaceans and a few isopods and amphipods, mainly occurring in small numbers and medium diversity.

A surprising sample was TVG 79, which hit a fossil coral reef mound on a ledge of a slope of a large guyot in about 1,500 m depth containing at least 10 different deep water coral species, around 10 different species of molluscs (mainly gastropods), 3 species of brachiopods in large numbers, a piece of a giant oyster shell, large cirriped shells and many shells of *Acesta angolensis*, a large limid bivalve (Nolf and Verstraeten, 2005). The shell bed was identified prior to sampling with the TV-grab on video. Before we reached the coarse sediment, the TV-grab was lowered down a slope for about 100 m, which was densely covered with large whip corals. Unfortunately, the resolution on the video is not good enough to see, whether living *Acesta* mussels are still present on this slope. The combination of deep water corals and supposedly shelf-associated molluscs plus the enormous number of *Acesta* shells implied that we were looking at a mixture of autochtonal coral diversity plus shallow water animals washed down the slopes of the guyot. The combination of *Acesta excavata* and deep water corals is well known from the North Atlantic, were these bivalves are associated with *Lophelia* reef mounds (López Correa et al., 2005). Our findings represent the South Atlantic counterpart with *Acesta angolensis* and a different combination of deep water corals only partly described previously (Zibrowius and Gili, 1990). The corals are currently photographed and identified. The fossil reef ecosystem will be described in collaboration with Prof. Dr. A. Freiwald, Senckenberg am Meer, Wilhelmshaven.

6.2.4 TV-Observation of the Sea Floor

Deployments of both TV-grab and TV-MUC revealed video tracks (i) from the surface to the seafloor and (ii) seafloor transects in suitable resolution for identification of taxa on a rather coarse, supraspecific level. We have not yet started video analysis, but taxon identification especially from the seafloor transects will certainly complement our understanding of the benthic communities in the collecting area.

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Appendix I: SO-233 Sampling Summary / Station List

Type	Stat.	Location	total volume	Rock summary	on bottom		off bottom		depth (m)	
					lat °S	long °E/W	lat °S	long °E/W	max	min
MUC	1	Abyssal plain E of southern Walvis Ridge	6 tubes	soft sediment	-32,817	3,067	-32,817	3,067	4879	4879
CTD	2	Abyssal plain E of southern Walvis Ridge	--	water	-32,834	3,000	--	--	2500	--
DR	3	southern Walvis Ridge, eastern "finger"	1/4 full	lava fragments, volcaniclastics, sedimentary rocks, Mn	-32,849	2,495	-32,855	2,504	2165	1578
DR	4	southern Walvis Ridge, eastern "finger"	one rock	volcanic breccia	-32,923	1,481	-32,922	1,485	3040	2565
DR	5	southern Walvis Ridge, eastern "finger"	2 rocks	volcanic breccia, sedimentary rock	-32,821	1,470	-32,821	1,478	2900	2496
DR	6	southern Walvis Ridge, central part	1 rock	volcanic breccia	-33,270	-0,312	-33,263	-0,316	2449	2025
DR	7	southern Walvis Ridge, central part	few rocks	sedimentary rocks	-33,274	-0,275	-33,267	-0,278	2643	2310
TVG	8	southern Walvis Ridge, central part	full	foram sand	-33,258	-0,487	-33,256	-0,490	1088	1211
DR	9	southern Walvis Ridge, central part	few rocks	volcaniclastics, Mn-crusts	-33,674	-0,751	-33,668	-0,753	2907	2501
DR	10	southern Walvis Ridge, central part	3 rocks	volcanic breccia, Mn-crusts	-33,672	-0,955	-33,667	-0,958	2981	2764
DR	11	southern Walvis Ridge, eastern "finger"	few rocks	solidified sediments	-30,685	2,199	-30,680	2,199	3000	2679
DR	12	southern Walvis Ridge, eastern "finger"	1/6 full	sedimentary rocks, Mn-crusts	-29,601	3,083	-29,595	3,080	2400	2005
DR	13	southern Walvis Ridge, eastern "finger"	few rocks	Mn-crusts	-29,605	3,105	-29,601	3,102	2552	2300
MUC	14	narrow part of Walvis Ridge, central area	empty	*MUC released at c. 2.000 m water depth due to high swell*	-28,917	2,662	--	--	3083	--
DR	15	narrow part of Walvis Ridge, eastern flank	2 rocks	lava fragments	-28,592	3,139	-28,597	3,133	3936	3661
DR	16	narrow part of Walvis Ridge, eastern flank	1 rock	lava fragment, fossile corals	-28,424	3,678	-28,426	3,673	3630	3186
MUC	17	abyssal plain E of narrow Walvis Ridge	6 tubes	soft sediment	-28,492	3,817	-28,493	3,818	4850	4862
TVG	18	smt. on E-flank of narrow Walvis Ridge	full	foram sand with clay	-28,448	3,632	-28,445	3,629	1626	1624
DR	19	narrow part of Walvis Ridge, eastern flank	1 rock	volcanic breccia	-28,437	3,656	-28,433	3,648	2549	2106
DR	20	narrow part of Walvis Ridge, eastern flank	3 rocks	volcanic breccia and conglomerate	-28,310	3,654	-28,311	3,655	2717	2792
DR	21	narrow part of Walvis Ridge, central area	3 rocks	sedimentary rocks	-27,956	3,128	-27,950	3,126	2694	2406
MUC	22	narrow part of Walvis Ridge, central area	empty	*sediment washed out*	-27,887	3,230	-27,887	3,230	3179	3179
DR	23	narrow part of Walvis Ridge, central area	empty		-27,908	3,155	-27,906	3,147	2863	2478
DR	24	narrow part of Walvis Ridge, central area	1 bloc	fossile coral reef with volcanic clasts	-27,947	3,147	-27,941	3,141	2928	2542
DR	25	narrow part of Walvis Ridge, central area	empty		-27,577	3,101	-27,577	3,093	2603	2401
DR	26	narrow part of Walvis Ridge, west. flank	empty		-27,339	3,013	-27,341	3,007	3200	2776
DR	27	narrow part of Walvis Ridge, western flank	2 rocks	volcanic breccia, Mn-crust	-27,258	2,962	-27,256	2,961	3364	3300
DR	28	narrow part of Walvis Ridge, western flank	few rocks	lava fragments, volcaniclastics	-26,306	3,044	-26,306	3,046	4100	3900
DR	29	narrow part of Walvis Ridge, western flank	1/2 full	lava fragments, volcaniclastics, sedimentary rock	-26,274	3,031	-26,280	3,027	3424	3133
MUC	30	abyssal plain W of norrow Walvis Ridge	1 tube	soft sediment	-26,230	3,097	-26,230	3,097	4722	4721
DR	31	narrow part of Walvis Ridge, western flank	empty		-26,286	3,061	-26,288	3,053	4687	4172
DR	32	narrow part of Walvis Ridge, western flank	2 rocks	lava fragments	-26,481	3,154	-26,481	3,152	4013	3500
DR	33	narrow part of Walvis Ridge, western flank	empty		-26,273	3,383	-26,277	3,380	3963	3666
DR	34	narrow part of Walvis Ridge, western flank	1 bloc	volcanic breccia (epiclastic) with lava clasts	-26,289	3,470	-26,291	3,461	4217	3817
DR	35	narrow part of Walvis Ridge, western flank	3/4 full	lava fragments, volcaniclastics	-26,221	3,313	-26,227	3,313	4063	3700
MUC	36	narrow part of Walvis Ridge, central area	3 tubes	soft sediment	-26,481	4,470	-26,481	4,470	2531	2530
DR	37	broad part of Walvis Ridge, western flank	1 rock	volcanic breccia (epiclastic) with lava clasts	-26,844	4,931	-26,838	4,928	3159	2720
DR	38	broad part of Walvis Ridge, western flank	1/6 full	slightly solidified sediment and sedimentary rocks	-26,683	5,333	-26,677	5,332	2589	2170

Appendix I: SO-233 Sampling Summary / Station List

Type	Stat.	Location	total volume	Rock summary	on bottom		off bottom		depth (m)	
					lat °S	long °E/W	lat °S	long °E/W	max	min
DR	39	broad part of Walvis Ridge, western flank	1/2 full	lava fragments, sedimentary rocks	-26,505	5,185	-26,509	5,180	2086	1830
DR	40	smt. SE of broad part of Walvis Ridge	1/4 full	lava fragments, sedimentary rocks	-26,819	5,609	-26,823	5,616	3577	3260
DR	41	smt. SE of broad part of Walvis Ridge	1/4 full	lava fragments, sedimentary rocks, Mn-crusts	-26,828	5,661	-26,442	5,658	2930	2664
MUC	42	abyssal plain E of broad Walvis Ridge	7 tubes	soft sediment	-26,870	5,440	-26,870	5,440	4033	4033
DR	43	broad part of Walvis Ridge, central area	few rocks	lava fragments	-26,717	4,945	-26,725	4,944	2440	2001
DR	44	broad part of Walvis Ridge, western flank	empty		-25,333	4,844	-25,355	4,846	2282	1921
DR	45	broad part of Walvis Ridge, western flank	few rocks	lava fragments, volcaniclastics, sedimentary rocks, Mn	-25,324	4,893	-25,331	4,890	2582	2181
DR	46	broad part of Walvis Ridge, western flank	few rocks	lava fragment, solidified sediment with Mn-crust	-25,139	4,962	-25,147	4,963	3306	2895
DR	47	broad part of Walvis Ridge, western flank	1 bloc	carbonate with Mn	-25,171	4,925	-25,179	4,925	2538	2157
DR	48	broad part of Walvis Ridge, western flank	1/2 full	lava fragments, volcaniclastics, carbonates	-25,083	4,589	-25,090	4,589	2965	2518
MUC	49	broad part of Walvis Ridge, western flank	empty	*sediment washed out*	-24,946	4,544	-24,946	4,544	4655	4647
DR	50	broad part of Walvis Ridge, western flank	1 rock	solidified sediment with Mn	-24,955	5,138	-24,962	5,140	3273	2896
DR	51	broad part of Walvis Ridge, central area	few rocks	carbonate, fossil corals, Mn-crusts	-25,182	5,684	-25,189	5,685	1540	1220
DR	52	broad part of Walvis Ridge, central area	1 rock?	carbonate	-25,209	5,656	-25,211	5,662	1687	1294
DR	53	broad part of Walvis Ridge, eastern flank	few rocks	sedimentary rocks, Mn-crusts	-25,993	6,514	-25,990	6,517	2163	1990
DR	54	broad part of Walvis Ridge, eastern flank	few corals	fossil corals	-26,535	6,221	-26,538	6,227	2777	2446
DR	55	broad part of Walvis Ridge, eastern flank	few rocks	carbonates	-26,492	6,194	-26,496	6,200	2459	2169
DR	56	broad part of Walvis Ridge, eastern flank	empty		-26,332	6,119	-26,334	6,123	1254	1063
TVG	57	broad part of Walvis Ridge, eastern flank	full	lava fragments, carbonates, soft sed. with lots of shells	-26,302	6,440	-26,307	6,448	1517	1666
DR	58	broad part of Walvis Ridge, eastern flank	empty		-26,388	6,495	-26,388	6,501	3216	3012
DR	59	broad part of Walvis Ridge, eastern flank	2 rocks	lava fragment, carbonate	-26,474	6,459	-26,474	6,469	3530	3085
DR	60	broad part of Walvis Ridge, eastern flank	2 rocks	lava fragments	-26,347	6,409	-26,347	6,416	2528	2226
DR	61	broad part of Walvis Ridge, eastern flank	empty		-25,874	6,608	-25,875	6,610	3736	3684
DR	62	broad part of Walvis Ridge, eastern flank	2 rocks	lava fragment, volcaniclastic rock	-25,851	6,606	-25,850	6,614	3765	3318
DR	63	broad part of Walvis Ridge, eastern flank	empty		-25,877	6,609	-25,880	6,611	3470	3106
DR	64	broad part of Walvis Ridge, eastern flank	few rocks	lava fragments	-25,363	6,721	-25,365	6,720	2930	2720
MUC	65	broad part of Walvis Ridge, central area	3 tubes	soft sediment (clayey)	-23,930	6,755	-23,930	6,755	2861	2861
DR	66	north. part of Walvis Ridge, eastern flank	few rocks	lava fragments, volcaniclastics	-22,711	7,571	-22,715	7,577	3871	3551
DR	67	north. part of Walvis Ridge, eastern flank	empty	*dredge lost*	-22,368	7,502			2235	
DR	68	north. part of Walvis Ridge, central area	empty	*dredge catched its chain bag*	-22,460	6,838	-22,467	6,839	2408	2105
DR	69	north. part of Walvis Ridge, central area	empty	*"eye" of dredge broken*	-22,470	6,816	-22,477	6,819	2246	1946
DR	70	north. part of Walvis Ridge, central area	empty		-22,461	6,837	-22,469	6,838	2569	1900
DR	71	north. part of Walvis Ridge, western flank	2 rocks	lava fragment, volcaniclastic rock	-22,663	5,122	-22,665	5,124	3115	2979
DR	72	north. part of Walvis Ridge, western flank	1 rock	volcaniclastic rock	-22,615	5,117	-22,620	5,123	3020	2687
DR	73	north. part of Walvis Ridge, western flank	empty		-22,428	5,104	-22,431	5,109	3350	3074
DR	74	north. part of Walvis Ridge, western flank	1 rock	lava fragment	-22,232	5,055	-22,236	5,055	3801	3584
DR	75	north. part of Walvis Ridge, western flank	1/4 full	lava fragments, volcaniclastics	-22,075	5,102	-22,080	5,103	4106	3578
MUC	76	abyssal plain N of northern Walvis Ridge	2 tubes	soft sediment	-21,600	5,022	-21,600	5,022	4463	4463
DR	77	seamounts N of northern Walvis Ridge	3 rocks	lava fragments	-21,216	5,069	-21,215	5,061	3273	2972

Appendix I: SO-233 Sampling Summary / Station List

Type	Stat.	Location	total volume	Rock summary	on bottom		off bottom		depth (m)	
					lat °S	long °E/W	lat °S	long °E/W	max	min
TVG	78	seamounts N of northern Walvis Ridge	empty	3 attempts failed to grabrocks/sed./fauna, batteries empty	-20,158	5,985	-20,170	5,985	2152	2147
TVG	79	seamounts N of northern Walvis Ridge	benthos	various organism (makro benthos)	-20,170	5,985	-20,170	5,985	2160	2169
DR	80	seamounts N of northern Walvis Ridge	few rocks	lava fragments	-20,212	5,926	-20,219	5,926	3608	3200
MUC	81	abyssal plain N of northern Walvis Ridge	6 tubes	soft sediment	-20,449	7,196	-20,449	7,196	4346	4345
DR	82	north. part of Walvis Ridge, NW-flank	1/6 full	sedimentary rocks	-20,485	7,339	-20,493	7,339	4213	3720
DR	83	north. part of Walvis Ridge, NW-flank	empty		-20,392	7,471	-20,398	7,472	4531	4000
DR	84	north. part of Walvis Ridge, NW-flank	few rocks	lava fragments, solidified sediment, chert	-20,340	7,635	-20,344	7,640	3794	3409
DR	85	north. part of Walvis Ridge, NW-flank	empty		-20,292	7,734	-20,292	7,742	4150	3714
TVG	86	north. part of Walvis Ridge, huge smt.	full	slighly solidified carbonates, corals	-20,787	8,685	-20,787	8,686	354	354
DR	87	north. part of Walvis Ridge, huge smt.	1/2 full	lava fragments, volcaniclastics, sedimentary rock, Mn	-20,644	8,628	-20,650	8,632	1848	1330
MUC	88	abyssal plain SE of norh. part of Walvis R.	7 tubes	soft sediment	-20,988	9,210	-20,988	9,210	3856	3856
DR	89	north. part of Walvis Ridge, NW-flank	1/8 full	lava fragments, volcaniclastics	-19,288	9,954	-19,293	9,957	2004	1619
DR	90	north. part of Walvis Ridge, NW-flank	few rocks	lava fragments	-18,447	10,883	-18,433	10,889	2532	2225
MUC	91	Namibian shelf NE of Walvis Ridge	7 tubes	soft sediment	-18,301	11,430	-18,301	11,430	421	421

Appendix II

(SO-233 Rock Description)

Abbreviations in Table Header:

UTC: Universal Time, Coordinated

TS: thin section billet
CHEM: chemistry slab to prepare materials for geochemical analysis
Ar/Ar: estimate of sample quality for $^{40}Ar/^{39}Ar$ dating
GL/MIN: potential glass and / or mineral separates
SED: sediment
REF: reference sample for immediate transport to home institution after cruise

Abbreviations for Minerals and Materials:

Fsp: feldspar
Plg: plagioclase
Ol: olivine
Px: pyroxene
CPx: clinopyroxene
Opx: orthopyroxene
Cc: clacite
Mn: manganese

Appendix II: SO-233 Rock Description

SO233-TV-MUC1

Description of Location and Structure: Abyssal plain east of bifurcated southwestern part of Walvis Ridge.

TV-MUC on bottom	UTC 18/05/14 14:32hrs, lat 32°49.02'S, long 3°04.02'E, depth 4879m
TV-MUC off bottom	UTC 18/05/14 14:34hrs, lat 32°49.02'S, long 3°04.02'E, depth 4879m
total volume:	6 tubes
Comments:	soft sediment and bottom water, water analyses O_2 56 % and salt content 4.7 %

SO233-CTD-2

Description of Location and Structure: Abyssal plain east of bifurcated southwestern part of Walvis Ridge.

CTD at 2500m b.s.l.	UTC 18/05/14 20:27hrs, lat 32°50.02'S, long 2°59.99'E, depth 4865m
CTD on deck	UTC 18/05/14 21:19hrs, lat 32°50.00'S, long 3°00.02'E, depth 4852m
Comments:	for update of sound velocity profile and biological sampling

SO233-DR3

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, eastern "finger". Upper western slope of guyot-like seamount on the southeastern margin of the "finger".

Dredge on bottom	UTC 19/05/14 01:18hrs lat 32°50.95'S long 2°29.72'E depth 2165m
Dredge off bottom	UTC 19/05/14 02:45hrs lat 32°51.27'S long 2°30.21'E depth 1578m
total volume:	1/4 full
Comments:	few angular lava fragments, volcaniclastic rocks, Mn-crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-3-1	1. Rock Type: volcanic 2. Size: 21x15x15 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: 20 % vesicles; porphyritic 6. Phenocrysts: 5-10 % altered Ol (< 3 mm), 5-10 % fresh Plg (< 1 mm) 7. Matrix: fine grained with brownish & black minerals (Cpx ?) 8. Secondary Minerals: refilled vesicles, maybe Cc 9. Encrustations: slight Mn crust 10. Comment: suitable for mineral separation and age dating	x	x	2-3					
SO233-DR-3-2	1. Rock Type: volcanic 2. Size: 20x13x12 cm 3. Shape / Angularity: subangular 10. Comment: similar to DR3-1	x	x	2-3					
SO233-DR-3-3	1. Rock Type: volcaniclastic rock (?), highly altered 2. Size: 24x13x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish-grey 5. Texture / Vesicularity: layering - dark bands and clasts (volcanic ?) 7. Matrix: very soft (cut with nail)	x							

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-3-4	1. Rock Type: volcaniclastic rock (?), highly altered 2. Size: 29x13.5x5.5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: very light 10. Comment: similar to DR3-3	x							
SO233-DR-3-5	1. Rock Type: volcaniclastic rock (?), highly altered 2. Size: 47x13x3 cm 3. Shape / Angularity: tabular, rounded 9. Encrustations: tiny Mn crust 10. Comment: similar to DR3-3	x							
SO233-DR-3-6	1. Rock Type: sediment (altered volcaniclastic breccia ?) 2. Size: 26x26x15 cm (big bloc) 3. Shape / Angularity: subangular 4. Color of cut surface: greenish - grey, reddish Cc - veins 10. Comment: clasts are usually ~ 2 cm, few recognizable volcanic clasts (~ 5 %)	x				x			
SO233-DR-3-7	1. Rock Type: sediment (altered breccia) 2. Size: 33x16x11 cm 3. Shape / Angularity: subangular, blocy 4. Color of cut surface: yellowish - brown 10. Comment: similar to DR3-6, but smaller clast, more recognizable volcanic clasts (~ 20 %)	x				x			
SO233-DR-3-8-S	1. Rock Type: sediment 2. Size: 14x10x8 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: few recognizable volcanic clasts (10 %) 10. Comment: altered with darkish veins					x			
SO233-DR-3-9-Mn	1. Rock Type: Mn crust 2. Size: 22x17x5 cm 3. Shape / Angularity: subangular 4. Color of surface: black								
SO233-DR-10-X	10. Comment: archive sample, large part of DR3-7								

Appendix II: SO-233 Rock Description

SO233-DR4

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge. Lower slope of western flank of the southern section of the eastern "finger".

Dredge on bottom	UTC 19/05/14 11:35hrs lat 32°55.37'S long 1°28.87'E depth 3040m
Dredge off bottom	UTC 19/05/14 13:04hrs lat 32°55.33'S long 1°29.03'E depth 2565m
total volume:	one rock
Comments:	Mn-encrusted volcanic breccia

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-4-1	1. Rock Type: volcaniclastic rock (breccia with at least one moderately preserved volcanic rock) 2. Size: 16x12x4 cm 3. Shape / Angularity: subangular fragments in Mn crust 4. Color of cut surface: brownish - grey fragments 5. Texture / Vesicularity: porphyritic, dense 6. Phenocrysts: ~ 5 % altered Ol (< 2 mm) , ~ 5 % Cpx (augite ?) or Amph with surroundings of Plg ? (< 3 mm), ~ 5 % Plg (< 1 mm) 7. Matrix: fine, fresh grey core surrounded by brown colored rim 9. Encrustations: Mn crust (0.5 - 2 cm) 10. Comment: alkalibasalt ? Suitable for GC but needs careful picking; Mn crust removed by chisel because too small for sawing; more fragments / material still within Mn crust	x		4					

SO233-DR5

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, eastern "finger". Same structure as DR4 but 6nm further north where slope is steeper.

Dredge on bottom	UTC 19/05/14 15:40hrs lat 32°49.28'S long 1°28.22'E depth 2900m
Dredge off bottom	UTC 19/05/14 18:30hrs lat 32°49.24'S long 1°28.66'E depth 2496m
total volume:	two rocks
Comments:	bridge took over at 2780m wire lengths; separation of two clasts (1-B & 1-C) from the volcaniclastic rock (1-A)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-5-1-A	1. Rock Type: volcaniclastic rock (conglomerate) 2. Size: 33x17x7 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: reddish - grey 7. Matrix: fine - coarse grained; calcite; calcite veins 8. Secondary Minerals: Cc 9. Encrustations: Mn crust 10. Comment: subrounded, unsorted volcanic clasts (up to 6 cm) in white matrix (Cc), biggest and freshest clast were separated (DR5-1B and -1C)								
SO233-DR-5-1-B	1. Rock Type: volcanic clast 2. Size: 6x5x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: greyish - yellow 5. Texture / Vesicularity: 10 - 20 % vesicularity, porphyritic (5 - 10 %) 6. Phenocrysts: altered Ol (< 2 mm), Plg (< 2 mm), black needles (< 0.5 mm; Cpx ?) 7. Matrix: fine grained, (Plg ?; Cpx ?) 8. Secondary Minerals: vesicles filled with Cc (~ 50 %) 10. Comment: filled vesicles connected with Cc veins, suitable for mineral separation if calcite is dissolved by acid	x							

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-5-1-C	1. Rock Type: volcanic clast 2. Size: 7x4x2 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: greyish - yellow 5. Texture / Vesicularity: porphyritic, 5 - 10 % vesicularity 6. Phenocrysts: ~ 5 % altered Ol (< 2 mm), 3 - 6 % Plg (< 2 mm), black needles (< 0.5 mm; Cpx ?) 7. Matrix: fine grained (Plg ? Cpx ?) 8. Secondary Minerals: vesicles filled with Cc (~ 40 %) 10. Comment: clast of DR5-1A	x							
SO233-DR-5-2	1. Rock Type: volcaniclastic rock, highly altered 2. Size: 14x10x14 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: reddish-yellow 5. Texture / Vesicularity: altered clasts (< 5 cm) 7. Matrix: coarse grained, clasts < 2 cm								

SO233-DR6

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, central part. Upper southeastern flank of a large guyot.

Dredge on bottom	UTC 20/05/14 05:51hrs lat 33°16.17'S long 0°18.74'W depth 2449m
Dredge off bottom	UTC 20/05/14 07:10hrs lat 33°15.78'S long 0°18.95'W depth 2025m
total volume:	one small rock
Comments:	Mn encrusted breccia, separation of two clasts (1A & 1B) from the breccia

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-6-1-A	1. Rock Type: volcanic rock fragment cut out from Mn-brecciated larger piece, quite fresh and more altered parts 2. Size: size of whole bloc: 12x8x4 cm; size of fragment: 4x4 cm 3. Shape / Angularity: rounded 4. Color of cut surface: grey core surrounded by brownish rim 5. Texture / Vesicularity: < 10 % vesicles filled with Cc and Mn 6. Phenocrysts: none (possibly former Ol phenocrysts (?) but completely replaced) 7. Matrix: fine grained 8. Secondary Minerals: Cc and Mn in vesicles 9. Encrustations: Mn crust (~ 10 mm) but cut off 10. Comment: suitable for groundmass Fsp separation for age dating (or just groundmass ?)	x	x	2					
SO233-DR-6-1-B	1. Rock Type: second volcanic rock fragment cut out from Mn-brecciated larger piece; highly altered 2. Size: 6x4x4 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: ~ 15 % vesicles, some empty, others filled with Cc and zeolites 7. Matrix: fine grained 8. Secondary Minerals: Cc in vesicles 9. Encrustations: Mn crust (~ 10 mm) but cut off								

SO233-DR7

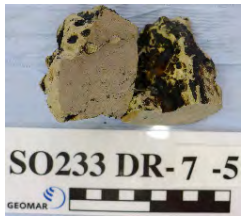
Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, central part. Southeastern flank of the DR6 guyot, slightly east of DR6 and slightly deeper.

Dredge on bottom UTC 20/05/14 09:15hrs lat 33°16.44'S long 0°16.50'W depth 2643m

Dredge off bottom UTC 20/05/14 10:30hrs lat 33°16.02'S long 0°16.65'W depth 2310m

total volume: 10 rocks

Comments: carbonate with plenty sand-size volcaniclastic fragments or mineral fragments?

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-7-1	1. Rock Type: volcaniclastic (?) sediment 2. Size: 13x7x10 cm 3. Shape / Angularity: subangular to rounded 4. Color of cut surface: white, light - grey 5. Texture / Vesicularity: clastic, no open cavities 6. Phenocrysts: mineral (?) and volcaniclastic fragments (1 - 4 mm), partly strongly altered 7. Matrix: cemented by white matrix (does not react with HCl) 9. Encrustations: Mn crust (< 1 mm) 10. Comment: if the fragments are minerals, sample might be suitable for mineral separation and dating	x			?	x			
SO233-DR-7-2-S	1. Rock Type: volcaniclastic (?) sediment 2. Size: 6x4x4 cm 3. Shape / Angularity: rounded 4. Color of cut surface: white - light grey 5. Texture / Vesicularity: clastic, no open cavities 6. Phenocrysts: lithic, volcaniclastic and mineral (?) fragments, 1 - 4 mm 7. Matrix: cemented by white matrix (does only weakly react with HCl) 10. Comment: possible mineral separation	x			?	x			
SO233-DR-7-3-S	1. Rock Type: volcaniclastic (?) sediment 2. Size: 11x11x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white - light grey 10. Comment: similar to DR7-1	x			?	x			
SO233-DR-7-4-S	1. Rock Type: clastic sediment 2. Size: 7x7x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white - light grey 10. Comment: similar to DR7-1	x			?	x			
SO233-DR-7-5-S	1. Rock Type: carbonatic sediment 2. Size: 11x6x5 cm 3. Shape / Angularity: subangular - subrounded 4. Color of cut surface: white 5. Texture / Vesicularity: dense, micritic texture 6. Phenocrysts: very small lithic fragments (< 1 mm) 7. Matrix: fine, micritic matrix 9. Encrustations: thin Mn crust (< 1 mm)	x				x			
SO233-DR-7-6-X	10. Comment: archive sample, similar to DR7-4	x				x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-7-7-X	10. Comment: archive sample, similar to DR7-4	x				x			
SO233-DR-7-8-X	10. Comment: archive sample, similar to DR7-4	x				x			
SO233-DR-7-9-X	10. Comment: archive sample, similar to DR7-4	x				x			
SO233-DR-7-10-X	10. Comment: archive sample, similar to DR7-4	x				x			

SO233-TVG8

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, central part, top plateau of DR6 and 7 guyot. Small mount approximately in the center of the plateau.

TVG on bottom	UTC 20/05/14 14:00hrs lat 33°15.49'S long 0°29.19'W depth 1088m
TVG off bottom	UTC 20/05/14 15:52hrs lat 33°15.35'S long 0°29.38'W depth 1211m
total volume:	full
Comments:	sandy sediment consisting of forams

SO233-DR9

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, central part. Middle section of the southeastern slope of the DR6 and 7 guyot, but 40nm to the southwest.

Dredge on bottom	UTC 20/05/14 22:24hrs lat 33°40.43'S long 0°45.03'W depth 2907m
Dredge off bottom	UTC 20/05/14 23:34hrs lat 33°40.06'S long 0°45.18'W depth 2501m
total volume:	12 rocks
Comments:	2 volcaniclastic rocks and the rest Mn crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-9-1	1. Rock Type: volcaniclastic rock 2. Size: 9x8x5 cm 3. Shape / Angularity: rounded 4. Color of cut surface: grey - yellow - brown 5. Texture / Vesicularity: angular (70 %) and rounded volcanic clasts (30 %) < 5 mm in white groundmass which does not react with HCl 9. Encrustations: thick Mn crust (~ 2 - 3 cm) 10. Comment: sorted volcanic (90 - 95 %) fragments as clasts with ~ 5 - 10 % white minerals (Fsp ?)	x							

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-9-2	1. Rock Type: volcaniclastic rock 2. Size: 17x12x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: grey - yellow - brown 10. Comment: similar to DR9-1								
SO233-DR-9-3-Mn	1. Rock Type: Mn crust 2. Size: 24x18x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: black								

SO233-DR10

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, central part. Same guyot as DR6, 7, and 9 but 12nm west of DR9 at the lower southern slope.

Dredge on bottom UTC 21/05/14 04:18hrs lat 33°40.29'S long 0°57.27'W depth 2981m

Dredge off bottom UTC 21/05/14 05:20hrs lat 33°39.99'S long 0°57.47'W depth 2764m

total volume: 3 rocks

Comments: volcanic breccias

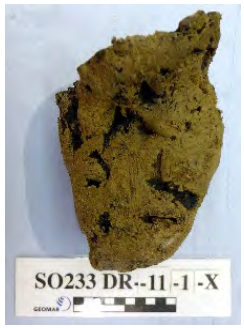
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-10-1	1. Rock Type: volcanic breccia 2. Size: 14x11x9 cm 3. Shape / Angularity: subangular 4. Color of cut surface: comprised of rounded and subangular reddish - grey clasts cemented by white material 5. Texture / Vesicularity: unsorted polyclasts (1 mm - 3 cm ø), < 10 % vesicles in basaltic clasts 7. Matrix: fine - coarse grained 8. Secondary Minerals: Mn, Cc 9. Encrustations: Mn crust (~ 1 mm) 10. Comment: some clasts look suitable for geochemistry but need careful separation / picking	x							
SO233-DR-10-2	1. Rock Type: volcanic breccia (one volcanic rock clast visible) 2. Size: 11x9x3.5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brownish - grey fragments enclosed in dark material 7. Matrix: fine grained matrix of breccia 8. Secondary Minerals: Mn, Cc ? 9. Encrustations: Mn crust (~ 1 mm)	x							
SO233-DR-10-3	1. Rock Type: "Mn and white material" - crust, without visible rock fragments 2. Size: 12x8x3 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brownish - grey 7. Matrix: colored white, fine grained (fizzes a little with HCl) 9. Encrustations: Mn crust								

Appendix II: SO-233 Rock Description

SO233-DR11

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, northern part of the eastern "finger". Lower slope of NW-SE trending large ridge-like, elongated seamount.

Dredge on bottom	UTC 22/05/14 14:45hrs lat 30°41.12'S long 2°11.95'E depth 3000m
Dredge off bottom	UTC 22/05/14 16:00hrs lat 30°40.81'S long 2°11.96'E depth 2679m
total volume:	few rocks
Comments:	soft silty sediment, 6 pieces up to 50 cm, partly with Mn crust on surface

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR11-1-X	1. Rock Type: soft, weakly consolidated sediment 2. Size: 10x20x15 cm 4. Color of cut surface: slightly brown 5. Texture / Vesicularity: dense, clay - silty texture 9. Encrustations: Mn crust 10. Comment: unusual small grain size (silt - clay), absence of pelagic microfossils ?					x			

SO233-DR12

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, northern tip of the eastern "finger". Upper eastern slope of a guyot right beneath the plateau edge.

Dredge on bottom	UTC 23/05/14 04:24hrs lat 29°36.03'S long 3°04.95'E depth 2400m
Dredge off bottom	UTC 23/05/14 05:33hrs lat 29°35.68'S long 3°04.81'E depth 2005m
total volume:	few rocks and 1 large bloc
Comments:	coral limestone with thin Mn crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR12-1-Mn	1. Rock Type: Mn crust 2. Size: 11x9x2 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brownish - grey 9. Encrustations: Mn crust (~ 2 mm)	x							
SO233-DR12-2-S	1. Rock Type: sedimentary (fossil coral reef) 2. Size: 9x7x4 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: white 9. Encrustations: Mn crust (~ 0.5 mm) 10. Comment: the white carbonate material hardly fizzes with HCl					x			
SO233-DR12-3-S	1. Rock Type: sedimentary (fossil coral reef) 2. Size: 11x7x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: white 9. Encrustations: Mn crust (~ 1 mm) 10. Comment: similar to DR12-2					x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR12-4-S-A	1. Rock Type: sedimentary (fossil coral reef) 10. Comment: similar to DR12-2. Bloc was separated into three smaller blocs (A - C)					x			
SO233-DR12-4-S-B	1. Rock Type: sedimentary (fossil coral reef) 10. Comment: similar to DR12-2. Bloc was separated into three smaller blocs (A - C)					x			
SO233-DR12-4-S-C	1. Rock Type: sedimentary (fossil coral reef) 10. Comment: similar to DR12-2. Bloc was separated into three smaller blocs (A - C)					x			

SO233-DR13

Description of Location and Structure: Bifurcated southwestern part of Walvis Ridge, northern tip of the eastern "finger". Same guyot as DR12, but 2nm further east and 400m below.

Dredge on bottom	UTC 23/05/14 07:40hrs lat 29°36.30'S long 3°06.29'E depth 2552m
Dredge off bottom	UTC 23/05/14 08:45hrs lat 29°36.08'S long 3°6.10'E depth 2300m
total volume:	few rocks
Comments:	Mn crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR13-1-Mn	1. Rock Type: Mn crust 2. Size: 28x16x7 cm 3. Shape / Angularity: subrounded 4. Color of surface: black								

Appendix II: SO-233 Rock Description

SO233-TV-MUC14

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section (branching area Gough / Tristan), central axis.

TV-MUC start	UTC 24/05/14 14:40hrs, lat 28°55.00'S, long 2°39.71'E, depth 3083m
TV-MUC on deck	UTC 24/05/14 15:58hrs, lat 28°54.90'S, long 2°39.50'E, depth 3083m
total volume:	empty
Comments:	cancelled at 2000m, flaps closed in water column because of high swell

SO233-DR15

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, eastern margin (slightly north of the DSDP sites). Southern slope of distinct, NW-SE striking valley.

Dredge on bottom	UTC 24/05/14 23:05hrs lat 28°35.50'S long 3°08.36'E depth 3936m
Dredge off bottom	UTC 25/05/14 00:21hrs lat 28°35.81'S long 3°8.00'E depth 3661m
total volume:	one big bloc and one small rock
Comments:	lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR15-1	1. Rock Type: volcanic 2. Size: 34x17x17 cm 3. Shape / Angularity: rounded; fresh, angular fragment broken off from one side 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: porphyritic, 20 % vesicularity, 80 % of vesicles are filled 6. Phenocrysts: at least 25 % altered Ol (< 8 mm), < 2 % Plg (< 3 mm) 7. Matrix: interstial Plg (< 0.5 mm) with black needle-like minerals (Px ?) 8. Secondary Minerals: vesicles are filled with white (zeolite ?) and transparent (Cc) material 9. Encrustations: minimal Mn crust 10. Comment: suitable for dating (fresh Plg); small perfect transparent and black crystals in some vesicles; divided into DR-1A (good quality) and DR-1B (rim)	x	x	2-3					
SO233-DR15-2	1. Rock Type: volcanic 2. Size: 11x11x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: porphyritic, 15 % vesicularity, 40 % of vesicles are filled 6. Phenocrysts: at least 25 % altered Ol 10. Comment: similar to DR15-1; shows clear contact to sediment with flow interaction (small shear bands in sediment)	x	x	2-3					

SO233-DR16

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, eastern margin. Southwestern wall of very steep, narrow, NW-SE striking canyon in the eastern flank of the ridge.

Dredge on bottom	UTC 25/05/14 09:46 hrs lat 28°25.381'S long 3°40.66'E depth 3630m
Dredge off bottom	UTC 25/05/14 11:03 hrs lat 28°25.574'S long 3°40.363'E depth 3186m
total volume:	1 rock, 2 coral fragments
Comments:	volcanic, potential px-cumulate?

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR16-1	1. Rock Type: volcanic, fresh 2. Size: 8x7x5 cm 3. Shape / Angularity: angular 4. Color of cut surface: dark grey 5. Texture / Vesicularity: dense, few filled vesicles 6. Phenocrysts: unclear mineralogy; possibly 20 % fresh to altered Opx ? (1 mm), 15 % Cpx (< 1 mm), 5 % altered Ol ?, Plg (<< 1 mm), spinel 7. Matrix: dense, partly greenish altered (chlorite ?) matrix 8. Secondary Minerals: white vesicle fillings 9. Encrustations: < 1 mm Mn crust on all surfaces of the rock; no "clean" surface; must have resided on the slope as clast 10. Comment: mineralogy is unclear; needs careful TS examination; tholeiitic or ankaramitic?	x	x	3					

SO233-TV-MUC17	
Description of Location and Structure: Abyssal plain east of the southern section of the narrow central part of Walvis Ridge.	
TV-MUC on bottom	UTC 25/05/14 15:05hrs, lat 28°29.50'S, long 3°49.00'E, depth 4850m
TV-MUC off bottom	UTC 25/05/14 15:30hrs, lat 28°29.60'S, long 3°49.10'E, depth 4862m
total volume:	6 tubes
Comments:	soft sediment and bottom water, water analyses O_2 48.8 %, salt content 4 % and temperature 6.7°

SO233-TVG18	
Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, eastern margin. Eastern plateau edge of a large guyot on the margin of the ridge.	
TVG on bottom	UTC 25/05/14 19:32hrs lat 28°26.90'S long 3°37.90'E depth 1626m
TVG off bottom	UTC 25/05/14 20:25hrs lat 28°26.72'S long 3°37.74'W depth 1624m
total volume:	full
Comments:	sandy sediment consisting of forams

SO233-DR19	
Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, eastern margin. Eastern slope of the TVG18 guyot, c. 1 nm southwest of DR16.	
Dredge on bottom	UTC 25/05/14 23:04hrs, lat 28°26.40'S, long 3°39.37'E, depth 2450m
Dredge off bottom	UTC 26/05/14 00:31hrs, lat 28°25.95'S, long 3°38.86'E, depth 2106m
total volume:	one rock
Comments:	volcaniclastic rock split into two clasts (1-A and 1-B) and the matrix (1-C)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-19-1-A	1. Rock Type: volcanic clast 2. Size: 11x9x8 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: porphyritic 6. Phenocrysts: 30 % medium altered to fresh Plg (< 1 cm), 2 - 5 % altered Ol (< 0.5 cm) and 1 - 3 % tiny black minerals (Amph or Px; << 1 mm) 7. Matrix: microcrystalline 9. Encrustations: Mn crust (2 - 3 cm) 10. Comment: fresh Plg suitable for age dating; mineralogy needs careful TS examination	x	x	1					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-19-1-B	1. Rock Type: volcanic clast 2. Size: 7x6x5 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: porphyritic, vesicularity 15 % 10. Comment: similar to DR-1-A, but fresher matrix	x	x	1					
SO233-DR-19-1-C	1. Rock Type: volcaniclastic rock 2. Size: 19x10x9 cm 3. Shape / Angularity: rounded, elongate 4. Color of cut surface: brownish - grey clasts in white groundmass 5. Texture / Vesicularity: angular to rounded clasts (excepted DR-1-A / B clast < 2 cm) 10. Comment: 80 % of clasts are similar to DR-1-A / B; 10 % highly vesicular (~ 50 %); 10 % dark grey; white groundmass does not react with HCl	x							

SO233-DR20

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, eastern margin. Lower eastern slope of the TVG18 guyot, ~8nm north of DR19.

Dredge on bottom	UTC 26/05/14 03:56hrs, lat 28°18.58'S, long 3°39.23'E, depth 2717m
Dredge off bottom	UTC 26/05/14 06:41hrs, lat 28°18.67'S, long 3°39.28'E, depth 2792m
total volume:	3 rocks
Comments:	volcaniclastic rocks, bridge took over at 2860m wire lengths

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-20-1-A	1. Rock Type: conglomerate composed of volcanic pebbles, cemented by white material and Mn crust. Two pebbles named -1-A and -1-B 2. Size: size of whole bloc: 13x8x7 cm, size of pebbles: 3x4x5 cm 3. Shape / Angularity: rounded pebbles 4. Color of cut surface: brown 5. Texture / Vesicularity: dense, few very small (< 1 mm) vesicles, some filled with secondary minerals 6. Phenocrysts: 5 % Plg needles (< 1 mm), 3 % Px (< 1 mm) 7. Matrix: fine grained 8. Secondary Minerals: Mn and Cc filling some vesicles, Mn on vein surfaces 9. Encrustations: Mn crust 10. Comment: note Mn on vein surfaces!	x	x	3-4					
SO233-DR-20-1-B	1. Rock Type: see -1-A 2. Size: see -1-A 3. Shape / Angularity: rounded pebbles 4. Color of cut surface: reddish-brown 5. Texture / Vesicularity: some small (< 1 mm) vesicles, often not filled 6. Phenocrysts: 5 % Plg (< 1 mm), 5 % Px (1 - 3 mm) 7. Matrix: fine grained 8. Secondary Minerals: Mn and Cc filling some vesicles, Mn on vein surfaces 9. Encrustations: Mn crust 10. Comment: see -1A	x	x	5					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-20-2	1. Rock Type: volcanic breccia, highly altered 2. Size: 13x11x5 cm 3. Shape / Angularity: subangular clasts 4. Color of cut surface: brown, red, grey clasts in white matrix 5. Texture / Vesicularity: < 20 % vesicles in less altered basalt clasts, < 5 % vesicles in highly altered (reddish) basalt clasts 6. Phenocrysts: 5 % Plg needles (< 1 mm) 7. Matrix: fine grained 8. Secondary Minerals: < 5 % Cc replacement (Ol) and vesicle fillings	x							
SO233-DR-20-3	1. Rock Type: volcanic breccia, highly altered 2. Size: 12x6x5.5 cm 3. Shape / Angularity: subangular clasts (1 - 3 cm in diameter) 4. Color of cut surface: reddish - grey clasts in yellowish - white matrix 5. Texture / Vesicularity: brecciated with < 2 % vesicles within the reddish-grey clasts 6. Phenocrysts: vary among clasts 7. Matrix: vary among clasts 8. Secondary Minerals: vary among clasts 9. Encrustations: Mn crust (~ 1 mm) 10. Comment: this rock comprises highly altered basaltic clasts, reddish in color	x							

SO233-DR21

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, central axis. Southeastern slope of a N-S elongated ridge-like structure most likely being formed of several seamounts.

Dredge on bottom	UTC 26/05/14 15:18hrs, lat 27°57.325'S, long 3°7.697'E, depth 2694m
Dredge off bottom	UTC 26/05/14 16:39hrs, lat 27°57.007'S, long 3°7.525'E, depth 2406m
total volume:	3 rocks
Comments:	one clastic sediment, two carbonate crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-21-1-S	1. Rock Type: clastic coarse sediment comprising different lithologies 2. Size: 9x8x3 cm 3. Shape / Angularity: flat, angular 4. Color of cut surface: brownish - yellow 8. Secondary Minerals: Mn 9. Encrustations: some Mn coating 10. Comment: may be used for separation ?					x			
SO233-DR-21-2-S	1. Rock Type: carbonate crust showing evidence of bioturbation 2. Size: 9x8x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white					x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-21-3-S	1. Rock Type: carbonate crust showing evidence of bioturbation 2. Size: 11x9x5.5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: white					x			

SO233-TV-MUC22	
Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, central axis. Plain east of the N-S elongated ridge-like structure and DR21, respectively.	
TV-MUC on bottom	UTC 26/05/14 20:09hrs, lat 27°53.20'S, long 3°13.80'E, depth 3179m
TV-MUC off bottom	UTC 26/05/14 20:11hrs, lat 27°53.20'S, long 3°13.80'E, depth 3179m
total volume:	empty
Comments:	sediment washed out during heaving

SO233-DR23	
Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, central axis. Lower part of the eastern slope of the N-S elongated structure, c. 3nm NNE of DR21.	
Dredge on bottom	UTC 26/05/14 23:07hrs, lat 27°54.50'S, long 3°09.32'E, depth 2863m
Dredge off bottom	UTC 27/05/14 00:30hrs, lat 27°54.36'S, long 3°8.84'E, depth 2478m
total volume:	empty
Comments:	

SO233-DR24	
Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, central axis. Lower part of the southeastern slope of the N-S elongated structure, c. 1nm northeast of DR21.	
Dredge on bottom	UTC 27/05/14 2:48hrs, lat 27°56.85'S, long 3°08.81'E, depth 2928m
Dredge off bottom	UTC 27/05/14 4:01hrs, lat 27°56.45'S, long 3°08.47'E, depth 2542m
total volume:	one huge bloc
Comments:	fossil coral reef with volcanic clasts, rock comprises many altered rock fragments. Given names DR24-1-A to -E

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-24-1-A	1. Rock Type: volcanic pebble 2. Size: 3x2x2 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: black and brownish - grey 5. Texture / Vesicularity: ~ 5 % vesicles (< 1 mm), partly filled with Cc (?) 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: Cc (?) 9. Encrustations: Mn crust (0.5 cm)								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-24-1-B	1. Rock Type: carbonate crust with volcanic fragments 2. Size: 23x14x11 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white with brownish fragments 5. Texture / Vesicularity: some fragments are vesicular, partly filled with Cc 7. Matrix: fine grained 8. Secondary Minerals: Cc 9. Encrustations: thin Mn crust (~ 1 mm)								
SO233-DR-24-1-C	1. Rock Type: carbonate crust with volcanic fragments 2. Size of fragments: ~ 4x3 cm 3. Shape / Angularity: subangular to subrounded 4. Color of cut surface: brown 5. Texture / Vesicularity: 30 - 40 % vesicles, partly filled with Cc (?) 7. Matrix: fine grained 8. Secondary Minerals: Cc (?) 9. Encrustations: Mn crust (~ 2 mm)								
SO233-DR-24-1-D	1. Rock Type: see -1-C 2. Size of fragments: ~ 2x2 cm 10. Comment: very similar to -1-C								
SO233-DR-24-1-E	1. Rock Type: see -1-C 2. Size of fragments: ~ 3x2 cm 10. Comment: very similar to -1-C		?						
SO233-DR-24-1-F-X to -T-X	10. Comment: more carbonate crusts with volcanic fragments are taken as archive samples								

SO233-DR25

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, western area. Upper eastern slope of the northernmost section of the eastern slope of the N-S elongated structure, c. 20nm north of DR21, 23 and 24.

Dredge on bottom	UTC 27/05/14 10:38hrs, lat 27°34.60'S, long 3°06.06'E, depth 2602m
Dredge off bottom	UTC 27/05/14 11:55hrs, lat 27°34.59'S, long 3°05.60'E, depth 2401m
total volume:	empty
Comments:	

SO233-DR26

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, western margin. Lower northern slope of small guyot on western flank.

Dredge on bottom	UTC 27/05/14 10:38hrs, lat 27°20.35'S, long 3°0.76'E, depth 3200m
Dredge off bottom	UTC 27/05/14 17:29hrs, lat 27°20.48'S, long 3°0.42'E, depth 2776m
total volume:	empty
Comments:	

SO233-DR27

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, western margin. Lower northern slope of small seamount (guyot?) located c. 5 nm NNW of DR26 on western flank.

Dredge on bottom	UTC 27/05/14 21:18hrs, lat 27°15.45'S, long 2°57.74'E, depth 3364m
Dredge off bottom	UTC 27/05/14 22:55hrs, lat 27°15.36'S, long 2°57.64'E, depth 3300m
total volume:	2 rocks
Comments:	volcaniclastic rocks and Mn crusts, bridge took over at 3360m wire lengths

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-27-1	1. Rock Type: volcaniclastic rock (breccia) 2. Size: 15x12x10 cm 3. Shape / Angularity: rounded 4. Color of cut surface: yellow - white 5. Texture / Vesicularity: volcanic clasts in white - yellow groundmass 6. Clasts: volcanic clasts with brown rim and palagonite clasts 8. Secondary Minerals: palagonite 9. Encrustations: Mn crust (2 - 3 cm) 10. Comment: clast separated (1-A to 1-D); matrix does not react with HCl								
SO233-DR-27-1-A	1. Rock Type: volcanic 2. Size: 2x2x2 cm 3. Shape / Angularity: rounded 4. Color of cut surface: grey 5. Texture / Vesicularity: aphyric, ~ 15 % vesicularity 7. Matrix: tiny altered Fsp (<< 0.5 mm) 8. Secondary Minerals: white material in 10 - 20 % of the vesicles								
SO233-DR-27-1-B	1. Rock Type: volcanic 2. Size: 4x3x2 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: aphyric, 15 % vesicularity 7. Matrix: tiny altered Fsp 8. Secondary Minerals: palagonite rim, former glass 10. Comment: palagonite rim indicates tiny part of pillow lava								
SO233-DR-27-1-C	1. Rock Type: volcanic 2. Size: 3x3x2 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 10. Comment: similar to DR27-1-B								
SO233-DR-27-1-D	1. Rock Type: volcanic 2. Size: 3x2x2 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 10. Comment: similar to DR27-1-B								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-27-2-Mn	1. Rock Type: Mn crust 2. Size: 8x6x3 cm 3. Shape / Angularity: tabular 4. Color of cut surface: tiny core is yellow - white and rim black 10. Comment: the core of the Mn crust is volcanic and is similar to DR27-1								

SO233-DR28

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, western margin. Lower eastern slope of N-S trending extension from the western flank.

Dredge on bottom	UTC 28/05/14 07:50hrs, lat 26°18.37'S, long 3°02.66'E, depth 4100m
Dredge off bottom	UTC 28/05/14 09:15hrs, lat 26°18.37'S, long 3°02.??'E, depth 3900m
total volume:	4 rocks
Comments:	volcanic rocks (3 lavas and 1 tuffaceous); bridge took over at 4230m wire lengths

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-28-1	1. Rock Type: volcanic rock, medium altered 2. Size: 19x12x6 cm 3. Shape / Angularity: subangular to angular 4. Color of cut surface: dark grey 5. Texture / Vesicularity: dense, no vesicles, aphyric 6. Phenocrysts: < 1 % reddish phenocrysts (1 - 2 mm) 7. Matrix: fine grained, yellow Fsp in glomerophyric texture, Cpx 9. Encrustations: very thin Mn crust (< 0.5 mm) 10. Comment: if fresh Fsp can be separated from altered ones, Fsp might be suitable for age dating	x	x	3-4					
SO233-DR-28-2	1. Rock Type: volcanic rock, highly altered 2. Size: 9x7x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brownish-grey 5. Texture / Vesicularity: 20 % vesicles, 2 types: 1 - 5 mm vesicles and < 1 mm vesicles, partly filled with secondary minerals; the larger ones are pipe vesicles 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: unidentified 9. Encrustations: very thin Mn crust (< 0.5 mm)	x	x						
SO233-DR-28-3	1. Rock Type: volcanic rock, highly altered 2. Size: 12x9x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish-grey 5. Texture / Vesicularity: ~ 3 % vesicles (< 1 mm), filled with secondary minerals 6. Phenocrysts: fresh Fsp-needles in altered matrix, ~ 5 % pseudomorphs of Ol (?) and/or Px (?) (< 1 mm) 7. Matrix: fine grained 8. Secondary Minerals: Mn? 9. Encrustations: thin Mn crust (< 1 mm) 10. Comment: fresh groundmass - Fsp may be suitable for age dating	x	x	2-3					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-28-4	1. Rock Type: tuffaceous or hyaloclastic, medium altered 2. Size: 9x7x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey with reddish vesicle fillings ? 5. Texture / Vesicularity: dense, pyroclastic texture, vesicles filled (amygdules) 8. Secondary Minerals: phyllosilicates replacing former glass shards 9. Encrustations: very thin Mn crust (< 1 mm) 10. Comment: could be tuffaceous or hyaloclastic material with glass completely replaced by clay minerals?	x							

SO233-DR29

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, western margin. Middle section of eastern slope of N-S trending extension from the western flank, c. 2nm NNE of DR28.

Dredge on bottom UTC 28/05/14 13:02hrs, lat 26°16.45'S, long 3°1.86'E, depth 3424m

Dredge off bottom UTC 28/05/14 14:21hrs, lat 26°16.82'S, long 3°01.59'E, depth 3133m

total volume: half full

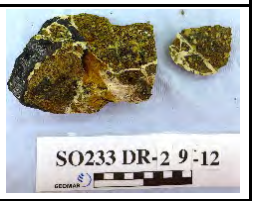
Comments: volcanic rocks, lava, volcanic sediments, one sediment; five different lithologies

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-29-1	1. Rock Type: volcanic, medium altered 2. Size: 12x11x7 cm 3. Shape / Angularity: angular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: aphyric with tiny microcrystals (<< 1 mm) in black and white matrix 6. Phenocrysts: ~ 5 - 10 % fresh to medium altered Plg (< 1 mm), ~ 25 % altered brown minerals (Ol ? or palagonite ?) or lithic fragments 7. Matrix: interstial Fsp and Cpx ? / Amph ? 10. Comment: sample could be tuffaceous consisting of ash and mineral fragments, mineralogy is unclear, needs careful TS examination, fresh Plg could be suitable for age dating	x	x	3					
SO233-DR-29-2	1. Rock Type: volcanic, medium altered 2. Size: 19x17x9 cm 3. Shape / Angularity: angular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR29-1, slightly more altered and brown minerals are up to 40 %	x	x	4					
SO233-DR-29-3	1. Rock Type: volcanic, altered 2. Size: 20x28x13 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 10. Comment: similar to DR29-2	x							

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-29-4	1. Rock Type: volcanic, altered 2. Size: 20x21x9 cm 3. Shape / Angularity: subangular, tabular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR29-2	x	x	4					
SO233-DR-29-5	1. Rock Type: volcanic 2. Size: 10x7x8 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: porphyritic, ~ 15 % vesicularity, nearly 90 % filled with white material 6. Phenocrysts: 10 - 15 % fresh Plg (< 1 mm) 10. Comment: similar to DR29-1								
SO233-DR-29-6	1. Rock Type: volcanic 2. Size: 12x12x10 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 5. Texture / Vesicularity: aphyric, ~ 25 - 30 % vesicularity 7. Matrix: interstial Plg (medium altered) 10. Comment: needs careful TS examination, could be suitable for age dating	x	x	2-4					
SO233-DR-29-7	1. Rock Type: volcanic 2. Size: 10x7x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 10. Comment: similar to DR29-6	x							
SO233-DR-29-8	1. Rock Type: volcanic 2. Size: 10x7x6 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 10. Comment: similar to DR29-6	x							
SO233-DR-29.9	1. Rock Type: volcanic 2. Size: 22x12x10 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown 10. Comment: similar to DR29-6 but more altered								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-29-10	1. Rock Type: volcaniclastic rock 2. Size: 27x16x13 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish - grey 5. Texture / Vesicularity: some subangular - subrounded lithic clasts 6. Clasts: similar clasts as DR29-1 and DR29-6, most clasts (90 %) show brown to black rims (palagonite ?), 10 % of the clasts consist of the rim material 7. Matrix: white groundmass which reacts minimally with HCl 10. Comment: needs careful TS examination; some clasts could be separated in order to obtain Fsp crystals for age dating; obtaining more clasts could help to determine the different lithologies and volcanic history								
SO233-DR-29-11	1. Rock Type: volcaniclastic rock 2. Size: 14x9x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish - grey 10. Comment: similar to DR29-10								
SO233-DR-29-12	1. Rock Type: volcaniclastic rock 2. Size: 15x9x6 cm 3. Shape / Angularity: subangular and elongated 4. Color of cut surface: greenish - grey 10. Comment: similar to DR29-10								
SO233-DR-29-13	1. Rock Type: volcaniclastic rock 2. Size: 13x10x11 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish - grey 10. Comment: similar to DR29-10								
SO233-DR-29-14	1. Rock Type: volcaniclastic rock 2. Size: 31x25x17 cm 3. Shape / Angularity: angular 4. Color of cut surface: greenish - grey 10. Comment: similar to DR29-10								
SO233-DR-29-15-S	1. Rock Type: sediment 2. Size: 27x21x9 cm 3. Shape / Angularity: subrounded, tabular 4. Color of cut surface: white 10. Comment: similar to DR21-2					x			
SO233-DR29-16-X	1. Rock Type: archive sample 10. Comment: part of sample taken as DR29-2								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-29-17-X	1. Rock Type: archive sample 10. Comment: part of sample taken as DR29-3								
SO233-DR-29-19-X	1. Rock Type: archive sample 10. Comment: part of sample taken as DR29-14								

SO233-TV-MUC30

Description of Location and Structure: Abyssal plain east of N-S trending extension from the western flank of the narrow central part of Walvis Ridge, c. 5 nm northeast of DR29.

TV-MUC on bottom	UTC 28/05/14 18:18hrs, lat 26°13.80'S, long 3°5.80'E, depth 4722m
TV-MUC off bottom	UTC 28/05/14 18:19hrs, lat 26°13.80'S, long 3°5.80'E, depth 4721m
total volume:	1 tube
Comments:	soft sediment

SO233-DR31

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, western margin. Base of the eastern slope of N-S trending extension from the western flank, c. 1nm east of DR28 and 29.

Dredge on bottom	UTC 29/05/14 00:18hrs, lat 26°17.13'S, long 3°3.67'E, depth 4687m
Dredge off bottom	UTC 29/05/14 01:40hrs, lat 26°17.25'S, long 3°3.12'E, depth 4143m
total volume:	empty
Comments:	

SO233-DR32

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, western margin. Lower flank of the margin, c. 3 nm east of N-S trending extension.

Dredge on bottom	UTC 29/05/14 09:14hrs, lat 26°28.85'S, long 3°09.23'E, depth 4013m
Dredge off bottom	UTC 29/05/14 11:13hrs, lat 26°28.88'S, long 3°09.12'E, depth 3500m
total volume:	2 rocks (and one small piece in sediment trap)
Comments:	volcanic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-32-1	1. Rock Type: volcanic, altered 2. Size: 11x10x7 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: 20 % vesicles, 70 % of these are filled 6. Phenocrysts: aphyric 7. Matrix: vesicular, fine grained, many Fsp 8. Secondary Minerals: vesicles filled with Cc 9. Encrustations: Mn crust (< 0.5 mm) 10. Comment: Fsp can be separated for age dating	x	x	2-3					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-32-2	1. Rock Type: volcanic, altered 2. Size: 9x8x4 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: greenish - brown 5. Texture / Vesicularity: holocrystalline with ~ 3 % filled vesicles (amygdules) 6. Phenocrysts: aphyric 7. Matrix: hollow, fine grained 8. Secondary Minerals: vesicles filled with Cc 9. Encrustations: Mn crust (~ 1 mm)	x	x						
SO233-DR-32-3	1. Rock Type: volcanic fragment from sediment trap 2. Size: 3x3x1 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 9. Encrustations: thin Mn crust (< 1 mm) 10. Comment: too small for GC bloc								

SO233-DR33

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, western margin. Lower northeastern slope of large guyot-like structure on western flank.

Dredge on bottom	UTC 29/05/14 18:26hrs, lat 26°16.38'S, long 3°22.97'E, depth 3963m
Dredge off bottom	UTC 29/05/14 19:33hrs, lat 26°16.63'S, long 3°22.77'E, depth 3666m
total volume:	empty
Comments:	

SO233-DR34

Description of Location and Structure: Narrow central part of Walvis Ridge, southern section, western margin. Lower northeastern slope of large guyot-like structure on western flank; c. 4nm east of DR33.

Dredge on bottom	UTC 29/05/14 23:09hrs, lat 26°17.32'S, long 3°28.20'E, depth 4217m
Dredge off bottom	UTC 30/05/14 00:23hrs, lat 26°17.44'S, long 3°27.66'E, depth 3817m
total volume:	one bloc
Comments:	volcaniclastic rock with volcanic clasts up to to 9 cm; clasts were separated

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-34-1	1. Rock Type: volcaniclastic rock 2. Size: 35x30x21 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish / brownish - grey 5. Texture / Vesicularity: angular - subangular volcanic clasts up to 9 cm, unsorted and with different degrees of alteration 10. Comment: DR34-1A to -1C are the biggest and freshest clasts, DR34-1D is the representative sample of the sediment, DR34-1X are archive samples consisting of volcanic clasts								
SO233-DR-34-1-A	1. Rock Type: volcanic 2. Size: 9x6x6 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: porphyritic, ~ 1 % vesicularity (~ 40 % are filled) 6. Phenocrysts: ~ 15 % fresh to slightly altered Plg (< 5 mm), greenish mineral (Ol ?, Cpx ?) surrounded by Plg 7. Matrix: fine grained, Plg and Cpx? (< 1 mm) 10. Comment: GC bloc could be prepared, could be suitable for age dating, if Plg are fresh	x		2-3					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-34-1-B	1. Rock Type: volcanic 2. Size: 8x5x3 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to DR34-1A			3-4					
SO233-DR-34-1-C	1. Rock Type: volcanic 2. Size: 5x3.5x3 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to DR34-1A								
SO233-DR-34-1-D	1. Rock Type: representative sampe of DR34-1 2. Size: 7x6x5 cm 10. Comment: see DR34-1								
SO233-DR-34-1-X	1. Rock Type: archive sample 10. Comment: several small (< 4 cm) volcanic clasts								

SO233-DR35

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, western margin. Middle section of northwestern slope of large guyot-like structure on western flank; c. 4nm northwest of DR33

Dredge on bottom	UTC 30/05/14 06:29hrs, lat 26°13.23'S, long 3°18.76'E, depth 4063m
Dredge off bottom	UTC 30/05/14 07:52hrs, lat 26°13.64'S, long 3°18.78'E, depth 3700m
total volume:	more than half full
Comments:	fresh volcanic rocks with glass rims

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-35-1	1. Rock Type: volcanic (pillow), fresh to slightly altered 2. Size: 50x40x20 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey core and brownish altered rim 5. Texture / Vesicularity: porphyritic, dense, minor vesicles (< 1 %) 6. Phenocrysts: 10 % Plg (1 - 5 mm), 1 % Ol (altered to iddingsite, 1 - 4 mm), Cpx ? 7. Matrix: fine grained (Fsp ?, Cpx ?) 8. Secondary Minerals: some clay minerals observed to have replaced some phenocrysts 9. Encrustations: Mn crust (< 1 mm) 10. Comment: glass rim at basalt columns, suitable for age dating, needs careful TS examination, two bags	x	x	1-2	gl				

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-35-2	1. Rock Type: volcanic, medium altered 2. Size: 17x8x8 cm 3. Shape / Angularity: angular (basalt column) 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: porphyritic, ~ 1 % vesicularity 6. Phenocrysts: 10 % Plg (1 - 5 mm), 1 % Ol (altered) 7. Matrix: fine grained (Fsp ?, Cpx ?) 8. Secondary Minerals: iddingsite (former Ol), few vesicles filled 9. Encrustations: Mn crust (< 1 mm) 10. Comment: glass rim, partly altered, fresh Plg, several filled veins	x			gl				
SO233-DR-35-3	1. Rock Type: volcanic, slightly to medium altered 2. Size: 17x14x8 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey 5. Texture / Vesicularity: porphyritic, dense 6. Phenocrysts: ~ 10 % fresh Plg (1 - 5 mm), ~ 1 % altered Ol (1 - 2 mm) 7. Matrix: fine grained (Plg ?, Cpx ?) 8. Secondary Minerals: iddingsite (former Ol), some clay minerals replacing Plg 9. Encrustations: Mn crust (< 1 mm) 10. Comment: suitable for age dating	x	x	1-2					
SO233-DR-35-4	1. Rock Type: volcanic, slightly to medium altered 2. Size: 17x9x10 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR-35-3 but ~ 20 % Plg (1 - 5 mm), 5 % altered Ol (< 2 mm), 1 - 2 filled vesicles, tiny (<< 1 mm) brown minerals in groundmass, suitable for age dating, needs careful TS examination	x	x	1-2					
SO233-DR-35-5	1. Rock Type: volcanic, medium altered 2. Size: 15x11x9 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey - brown (altered part of rock) 5. Texture / Vesicularity: ~ 3 % vesicularity, porphyritic 6. Phenocrysts: ~ 10 % Plg (< 3 mm), ~ 1 % altered Ol (1 - 2 mm) 7. Matrix: fine grained 8. Secondary Minerals: minor vesicles filled with white material, iddingsite (former Ol) 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: suitable for age dating, needs careful TS examination	x	x	1-2					
SO233-DR-35-6	1. Rock Type: volcanic, slightly altered 2. Size: 17x9x7 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: < 1 % vesicles (partly filled), porphyritic 6. Phenocrysts: ~ 10 % Plg (< 3 mm), ~ 1 % altered Ol (1-2 mm) 7. Matrix: fine grained 8. Secondary Minerals: red - brownish material in some vesicles 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: part of bloc N; suitable for age dating, needs careful TS examination	x	x	1-2					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-35-7	1. Rock Type: volcanic 2. Size: 12x8x6 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to DR35-6, suitable for age dating, needs careful TS examination	x	x	1-2					
SO233-DR-35-8	1. Rock Type: volcanic 2. Size: 10x11x12 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey - brown 10. Comment: similar to DR35-3	x							
SO233-DR-35-9	1. Rock Type: volcanic 2. Size: 14x12x8 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: < 1 % unfilled vesicles, porphyritic 10. Comment: similar to DR35-4, but ~ 13 % Plg, < 1 % Ol, cracks with Cc ? filling	x							
SO233-DR-35-10	1. Rock Type: volcanic 2. Size: 26x10x15 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: dense, porphyritic 6. Phenocrysts: ~ 10 % Plg, ~ 3 % Ol 7. Matrix: fine grained, Plg ?, Cpx ?, Ol ? 8. Secondary Minerals: iddingsite (former Ol) 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: part of bloc E, suitable for age dating, needs careful TS examination	x	x	1-2					
SO233-DR-35-11	1. Rock Type: volcanic (coarse grained pillow) 2. Size: 22x10x7 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: < 1 % vesicularity, porphyritic 6. Phenocrysts: ~ 5 % Plg, ~ 5 % altered Ol 7. Matrix: coarser than previous samples, Plg, Ol? Cpx? 8. Secondary Minerals: iddingsite (former Ol), Cc 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: suitable for age dating, needs careful TS examination	x							
SO233-DR-35-12	1. Rock Type: volcanic (pillow) 2. Size: 23x12x14 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to DR35-11, but ~ 15 % Plg, ~ 5 % Ol	x	x	1-2					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-35-13	1. Rock Type: volcanic (pillow with vesicles), slightly altered 2. Size: 19x10x10 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey 5. Texture / Vesicularity: 5 % vesicularity, porphyritic 6. Phenocrysts: ~ 5 % Plg (1 - 8 mm; few are zoned), ~ 1 % altered Ol 7. Matrix: fine grained, patchy matrix with lighter (> Fsp) and darker (> Px and / or Ol) areas 8. Secondary Minerals: iddingsite (former Ol), filled vesicles (white - green material) 9. Encrustations: Mn crust (< 1 mm) 10. Comment: suitable for age dating, needs careful TS examination	x	x	1-2					
SO233-DR-35-14	1. Rock Type: volcanic (dense aphyric pillow), slightly to medium altered 2. Size: 22x12x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish- grey 5. Texture / Vesicularity: 5 % vesicularity, slightly porphyritic (~ 2 % macrocrysts) 6. Phenocrysts: < 1 % Plg (< 2 mm), < 1 % altered Ol (< 1 mm) 7. Matrix: fine grained, white (Fsp ?) and black - brown minerals (Px ?, Amph ? or Ol ?) 8. Secondary Minerals: few Plg and most Ol are replaced 9. Encrustations: Mn crust (< 1 mm) 10. Comment: suitable for age dating but needs careful TS examination	x	x	1-2					
SO233-DR-35-15	1. Rock Type: volcanic (dense aphyric pillow) 2. Size: 6x5x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR35-13, but only ~ 5 % phenocrysts	x							
SO233-DR-35-16	1. Rock Type: volcanic (pillow basalt), medium to highly altered 2. Size: 15x11x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: porphyritic 6. Phenocrysts: ~ 15 % Plg needles (< 2 mm) 7. Matrix: homogeneous brown matrix 9. Encrustations: glass rim 10. Comment: suitable for age dating, needs careful TS examination	x	x	1-2	gl				
SO233-DR-35-17	1. Rock Type: volcanic (pillow basalt) 2. Size: 9x7x5 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 5. Texture / Vesicularity: < 1 % vesicularity, porphyritic 6. Phenocrysts: ~ 5 % zoned Plg (< 2 mm), ~ 10 % Plg needles 10. Comment: similar to DR35-16	x							

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-35-18	1. Rock Type: volcaniclastic rock (tuffaceous) 2. Size: 11x8x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 5. Texture / Vesicularity: compact, lithic and mineral fragments (Plg?, altered Ol?) 10. Comment: needs careful TS examination	x	x						
SO233-DR-35-19	1. Rock Type: volcaniclastic rock (breccia) 2. Size: 14x12x10 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown, clasts are dark brown to light brown 5. Texture / Vesicularity: < 10 % vesicularity in clasts 6. Phenocrysts: in clasts < 5 % Plg and < 1 % Ol 7. Matrix: fine grained 8. Secondary Minerals: Cc 10. Comment: clasts consist of the volcanics described in DR35	x							
SO233-DR-35-20-X to 34-X	10. Comment: archive samples, similar to DR35-1 to DR35-9 and according glass								
SO233-DR-35-35-X to 41-X	10. Comment: archive samples, similar to DR35-1 to DR35-9 without glass								
SO233-DR-35-42-X	10. Comment: archive sample, similar to DR35-10								
SO233-DR-35-43-X to 44-X	10. Comment: archive samples, similar to DR35-11 and DR35-12								
SO233-DR-35-45-X to 46-X	10. Comment: archive samples, similar to DR35-13								
SO233-DR-35-47-X	10. Comment: archive sample, similar to DR 35-14								
SO233-DR-35-48-X	10. Comment: archive sample, parts of bloc M, also DR35-51								

SO233-TV-MUC36

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, central plain.

TV-MUC on bottom	UTC 30/05/14 16:59hrs, lat 26°28.84'S, long 4°28.17'E, depth 2531m
TV-MUC off bottom	UTC 30/05/14 17:04hrs, lat 26°28.17'S, long 4°28.17'E, depth 2530m
total volume:	3 tubes with 5 - 10 cm sediment
Comments:	soft sediment and bottom water, salt content 3,39 %, O_2 46 % and pH 7.27

SO233-DR37

Description of Location and Structure: Broad central part of Walvis Ridge, northern section, eastern margin. Middle section of the southeastern flank of the ridge south of distinct graben structure.

Dredge on bottom	UTC 31/05/14 01:17hrs, lat 26°50.64'S, long 4°55.84'E, depth 3159m
Dredge off bottom	UTC 31/05/14 02:33hrs, lat 26°50.25'S, long 4°55.67'E, depth 2720m
total volume:	one rock
Comments:	volcaniclastic rock, two clasts were separated

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-37-1	1. Rock Type: volcaniclastic rock (breccia) 2. Size: 27x19x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown and white 5. Texture / Vesicularity: brown angular to rounded clasts up to 9 cm in white matrix 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: DR37-1A and DR37-1B were separated								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-37-1-A	1. Rock Type: volcanic (clast from DR37-1), highly altered 2. Size: 7x7x8 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: porphyritic 6. Phenocrysts: ~ 20 % fresh Plg with inclusions and zonation, ~ 1 % altered Ol 7. Matrix: homogeneous 8. Secondary Minerals: Cc in big crack 10. Comment: tiny filled black cracks, Plg could be suitable for age dating, needs careful TS examination	x	x	2-4					
SO233-DR-37-1-B	1. Rock Type: volcanic (clast from DR37-1) 2. Size: 6x3x3 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 10. Comment: similar to DR37-1A	x	x	2-4					

SO233-DR38

Description of Location and Structure: Broad central part of Walvis Ridge, northern section, eastern margin. Upper slope of the southeastern flank of the ridge south of distinct graben structure, c. 4nm northeast of DR37.

Dredge on bottom	UTC 31/05/14 08:44hrs, lat 26°40.95'S, long 5°19.97'E, depth 2600m
Dredge off bottom	UTC 31/05/14 02:33hrs, lat 26°40.61'S, long 5°19.94'E, depth 2170m
total volume:	few rocks
Comments:	unconsolidated sediment and two sedimentary rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR38-1	1. Rock Type: carbonatic breccia with lithic fragments 2. Size: 20x12x8 cm 3. Shape / Angularity: angular 7. Matrix: carbonate 8. Secondary Minerals: Cc, green and yellow minerals 10. Comment: contains shell-like calcite fragments	x				x			
SO233-DR38-2	1. Rock Type: see DR38-1 2. Size: 25x20x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish-grey					x			
SO233-DR38-3	1. Rock Type: see DR38-1 2. Size: 8x8x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: yellowish-grey					x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR38-4-S	1. Rock Type: micritic limestone 2. Size: 12x10x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white 10. Comment: no lithic fragments					x			
SO233-DR38-5-S	1. Rock Type: see DR38-4 2. Size: 12x10x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white 10. Comment: no lithic fragments					x			

SO233-DR39

Description of Location and Structure: Broad central part of Walvis Ridge, northern section, eastern margin. Lower slope of the southeastern flank of the distinct graben structure.

Dredge on bottom	UTC 31/05/14 14:47hrs, lat 26°30.27'S, long 5°11.08'E, depth 2086m
Dredge off bottom	UTC 31/05/14 15:58hrs, lat 26°30.53'S, long 5°10.79'E, depth 1830m
total volume:	half full
Comments:	volcanics, volcaniclastic rocks and carbonates

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-39-1	1. Rock Type: volcanic, fresh 2. Size: 35x26x15 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: patchy aphyric, ~ 1 % vesicularity (mostly filled) 7. Matrix: fine grained, fresh Plg 8. Secondary Minerals: carbonate or chalcedone in vesicles 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: bloc C; needs careful TS examination, matrix could be suitable for age dating	x	x	2?					
SO233-DR-39-2	1. Rock Type: volcanic, moderately altered 2. Size: 30x27x13 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey, altered parts brown 5. Texture / Vesicularity: ~ 1 % vesicularity, aphyric, orientated brown bands 7. Matrix: fine grained (Cpx ?, Plg ?) 10. Comment: two bags, altered and fresh sample, bloc E, needs careful TS examination and mineral separation (Plg), matrix could be suitable for age dating	x	x	2-3					
SO233-DR-39-3	1. Rock Type: volcanic, moderately altered 2. Size: 22x16x9 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR39-2	x	x						

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-39-4	1. Rock Type: volcanic, moderately altered 2. Size: 21x11x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR39-2	x							
SO233-DR-39-5	1. Rock Type: volcanic, moderately altered 2. Size: 38x21x14 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR39-2, bloc F	x	x						
SO233-DR-39-6-X	10. Comment: archive sample, similar to DR39-2								
SO233-DR-39-7	1. Rock Type: volcanic 2. Size: 15x12x9 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 5. Texture / Vesicularity: ~ 1 % vesicularity, mostly filled, aphyric 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: carbonates in vesicles 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: needs careful TS examination, tuffaceous ?								
SO233-DR-39-8	1. Rock Type: volcanic 2. Size: 10x8x4 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 10. Comment: similar to sample DR39-7								
SO233-DR-39-9	1. Rock Type: volcanic 2. Size: 11x8x5 3. Shape / Angularity: subangular 4. Color of cut surface: reddish - brown 5. Texture / Vesicularity: ~ 25 % vesicularity 7. Matrix: fine grained 8. Secondary Minerals: vesicles filled with black material 10. Comment: similar to DR39-7, Cc veins	x							
SO233-DR-39-10-X	10. Comment: archive sample, similar to DR-39-2, but more altered								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-39-11	1. Rock Type: volcanic 2. Size: 10x6x5 cm 3. Shape / Angularity: angular 4. Color of cut surface: reddish - brown 5. Texture / Vesicularity: ~ 20 % vesicularity (5 % filled with black (Mn ?) and white material) 10. Comment: similar to DR39-7, Cc veins								
SO233-DR-39-12	1. Rock Type: volcanic 2. Size: 18x17x6 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 10. Comment: similar to DR39-7	x	x						
SO233-DR-39-13	1. Rock Type: volcanic 2. Size: 20x12x13 cm 3. Shape / Angularity: angular 4. Color of cut surface: reddish - brown 10. Comment: similar to DR39-7, but ~ 20 % vesicularity								
SO233-DR-39-14	1. Rock Type: volcanic 2. Size: 14x10x4 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 10. Comment: similar to DR39-7, but ~ 3 % vesicularity								
SO233-DR-39-15	1. Rock Type: volcanic 2. Size: 13x10x9 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: vesicularity ~ 30 % (filled with white - black (Mn ?) material), aphyric 6. Phenocrysts: aphyric 7. Matrix: fine grained 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: mineralogy unclear, needs careful TS examination	x	x						
SO233-DR-39-16	1. Rock Type: volcanic 2. Size: 12x10x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: ~ 20 % vesicularity (~ 30 % filled), aphyric 6. Phenocrysts: aphyric 7. Matrix: very fine grained 10. Comment: filled vesicles, some have white carbonate rim with transparent to greenish white cores (chalcedone ?), filled cracks								
SO233-DR-39-17-X	10. Comment: archive sample, similar to DR39-16								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-39-18-X	10. Comment: archive sample, similar to DR39-16								
SO233-DR-39-19	1. Rock Type: volcanic 2. Size: 22x17x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 10. Comment: similar to DR39-16	x							
SO233-DR-39-20	1. Rock Type: volcanic 2. Size: 13x13x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown - red 10. Comment: similar to DR39-16, but more dense and without cracks, filled pores with green rim, two TS	x	x						
SO233-DR-39-21	1. Rock Type: volcanic 2. Size: 45x25x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - brown 10. Comment: similar to DR39-16, bloc G	x	x						
SO233-DR-39-22	1. Rock Type: volcanic 2. Size: 18x14x13 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brownish - red 5. Texture / Vesicularity: aphyric 6. Phenocrysts: ~ 2 % Plg (< 2 mm) 7. Matrix: homogeneous 9. Encrustations: Mn crust (~ 0.5 mm) 10. Comment: filled cracks with white material and red rim, needs careful TS examination	x							
SO233-DR-39-23-X	10. Comment: archive sample, similar to DR39-22								
SO233-DR-39-24-X	1. Rock Type: sediment (carbonate) 2. Size: 13x6x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white 5. Texture / Vesicularity: ~1 % vesicularity 9. Encrustations: Mn crust (1 - 2 mm)					x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-39-25-X	1. Rock Type: sediment (carbonate) 2. Size: 22x14x9 cm 3. Shape / Angularity: angular 4. Color of cut surface: white 5. Texture / Vesicularity: ~ 1 % vesicularity 10. Comment: small clasts in matrix (1 - 2 mm)					x			
SO233-DR-39-26-S	1. Rock Type: sediment (carbonate) 2. Size: 67x38x21 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white - grey - orange 9. Encrustations: partly Mn crust (< 1 mm) 10. Comment: bloc H					x			
SO233-DR-39-27	1. Rock Type: volcaniclastic rock 2. Size: 20x24x10 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: green 5. Texture / Vesicularity: black to brown angular to subrounded clasts up to 1.5 cm 10. Comment: slightly altered, bloc N								
SO233-DR-39-28-X	10. Comment: archive sample, similar to DR39-26					x			
SO233-DR-39-29	1. Rock Type: volcaniclastic rock (breccia), altered 2. Size: 24x14x8 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: green - brown 5. Texture / Vesicularity: several subrounded to angular volcanic clasts up to 1 cm								

SO233-DR40

Description of Location and Structure: Broad central part of Walvis Ridge, northern section, eastern margin. Lower northern slope of N-S elongated seamount south of the southeastern flank of the ridge.

Dredge on bottom	UTC 01/06/14 09:32hrs, lat 26°49.14'S, long 5°36.55'E, depth 3577m
Dredge off bottom	UTC 01/06/14 10:35hrs, lat 26°49.39'S, long 5°36.39'E, depth 3260m
total volume:	few rocks
Comments:	several large sedimentary boulders, one big volcanic rock

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-40-1	1. Rock Type: volcanic rock (pillow lava) 2. Size: 50x40x40 cm 3. Shape / Angularity: round pillow 4. Color of cut surface: brownish grey 5. Texture / Vesicularity: dense at rim, up to 20 % vesicles in inner part of pillow 6. Phenocrysts: 40 % Plg-microphenocrysts 7. Matrix: very fine grained 8. Secondary Minerals: only Mn crusts, some vesicle fillings 9. Encrustations: Mn crust 10. Comment: letter "F" on photo, Plg-microphenocrysts could be used for separation and age dating	x	x	3					
SO233-DR-40-1-X	10. Comment: same as DR-40-1, taken for archive (for mineral separation)								
SO233-DR-40-2-S	1. Rock Type: sediment 2. Size: 40x30x20 cm 3. Shape / Angularity: subrounded 4. Color of surface: yellowish					x			

SO233-DR41

Description of Location and Structure: Broad central part of Walvis Ridge, northern section, eastern margin. Middle section of the northern slope of N-S elongated seamount south of the southeastern flank of the ridge, c. 0.5nm east of DR40.

Dredge on bottom	UTC 01/06/14 13:25hrs, lat 26°49.66'S, long 5°39.64'E, depth 2930m
Dredge off bottom	UTC 01/06/14 14:45hrs, lat 26°50.09'S, long 5°39.50'E, depth 2664m
total volume:	few big rocks
Comments:	volcanics, sediments and Mn crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-41-1	1. Rock Type: volcanic, medium altered 2. Size: 15x15x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: ~ 20 % vesicularity, completely filled, porphyritic 6. Phenocrysts: ~ 10 % altered Ol, ~ 5 % Plg 7. Matrix: fine grained 8. Secondary Minerals: vesicles filled with Cc 9. Encrustations: Mn crust (2 - 3 cm)	x	x	?					
SO233-DR-41-2	1. Rock Type: volcanic, altered 2. Size: 30x24x10 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: ~ 30 % vesicles, porphyritic 10. Comment: similar to DR41-1, two TS	x	x	?					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-41-3-S	1. Rock Type: sediment 2. Size: 10x8x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: white 10. Comment: medium degree of consolidation					x			
SO233-DR-41-4-S	1. Rock Type: sediment (fossil coral reef) 2. Size: 17x15x7 cm 3. Shape / Angularity: subangular 4. Color of surface: white 10. Comment: more consolidated than DR41-3					x			
SO233-DR-41-5-Mn	1. Rock Type: Mn crust 2. Size: 15x15x13 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: black 5. Texture / Vesicularity: massive								

SO233-TV-MUC42

Description of Location and Structure: Abyssal plain south of the northern section of the broad central part of Walvis Ridge, inbetween DR40/41 seamount and southeastern ridge margin.

TV-MUC on bottom	UTC 01/06/14 18:44hrs, lat 26°52.20'S, long 5°26.40'E, depth 4044m
TV-MUC off bottom	UTC 01/06/14 18:45hrs, lat 26°52.20'S, long 5°26.40'E, depth 4033m
total volume:	7 tubes full
Comments:	soft sediment and bottom water, salt content 3.36 %, O_2 46.6 % and pH 8.0

SO233-DR43

Description of Location and Structure: Broad central part of Walvis Ridge, northern section, eastern margin. Southeastern flank (from base to top) of the ridge south of distinct graben structure, c. 18nm southwest of DR39.

Dredge on bottom	UTC 02/06/14 00:23hrs, lat 26°43.01'S, long 4°56.69'E, depth 2440m
Dredge off bottom	UTC 02/06/14 01:42hrs, lat 26°43.47'S, long 4°56.63'E, depth 2001m
total volume:	10 rocks
Comments:	volcanic

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-43-1	1. Rock Type: volcanic (Ol basalt ?) 2. Size: 30x21x11 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: ~ 10 % vesicularity (completely filled), porphyritic 6. Phenocrysts: altered Ol replaced by Cc ~ 15 % (< 1 cm), ~ 2 % green Cpx (diopside?) (< 4 mm), Plg needles 7. Matrix: fine grained, Plg and Cpx ? 8. Secondary Minerals: Cc, white vesicles filling 9. Encrustations: Mn crust (< 1 mm) 10. Comment: Cc veins, part of the sample is volcaniclastic, needs careful TS examination; age dating is possible, but needs careful picking	x	x	2-3					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-43-2	1. Rock Type: volcanic 2. Size: 12x9x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR43-1, Cpx are up to 12 mm, vesicles are mostly near the rim	x							
SO233-DR-43-3	1. Rock Type: volcanic 2. Size: 16x13x10 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: ~ 10 % vesicularity (mostly open), porphyritic 6. Phenocrysts: ~ 15 % Plg (< 12 mm), ~ 2 % altered Ol (< 3 mm) 7. Matrix: fine grained 8. Secondary Minerals: Cc veins 9. Encrustations: Mn crust (< 1 mm) 10. Comment: matrix is unclear, needs TS examination, suitable for age dating	x	x	2					
SO233-DR-43-4	1. Rock Type: volcanic 2. Size: 22x10x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: ~ 10 % vesicularity (mostly open), porphyritic 6. Phenocrysts: ~ 10 % Plg (< 5 mm) 7. Matrix: fine grained 8. Secondary Minerals: Cc 9. Encrustations: Mn crust (< 2 cm) 10. Comment: similar to DR43-3, but more Cc veins	x	x	2					
SO233-DR-43-5	1. Rock Type: volcanic 2. Size: 20x20x21 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: some large vesicles (~ 5 %) filled with white - yellow material 6. Phenocrysts: ~ 1 % Ol (< 1 cm) replaced by Cc, < 1 % Plg 7. Matrix: fresh, fine grained 8. Secondary Minerals: Cc 9. Encrustations: Mn crust (< 1mm) 10. Comment: small black minerals in Matrix (Cpx oxidized?), if fresh Plg in matrix, the matrix is suitable for age dating	x	x	2-3					
SO233-DR-43-6	1. Rock Type: volcanic 2. Size: 18x16x15 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: dense, porphyritic 10. Comment: similar to DR43-5, but more phenocrystic Plg (~ 10 %) and less Ol (5 - 7 %), 1 - 2 mm Mn crust	x	x	2					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-43-7	1. Rock Type: volcanic 2. Size: 21x13x10 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey with altered rim (brown) 5. Texture / Vesicularity: ~ 7 % vesicularity (open) 10. Comment: similar to DR43-5, but larger Ol (< 5 mm) and Plg (< 1 cm)	x	x						
SO233-DR-43-8	1. Rock Type: volcanic 2. Size: 18x18x16 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to sample DR43-6, but more cracks (Cc ? filling)	x	x						
SO233-DR-43-9	1. Rock Type: volcanic 2. Size: 23x20x11 cm 3. Shape / Angularity: subangular 4. Color of cut surface: red - brown 10. Comment: similar to DR39-22, but has also yellow minerals and silicate veins	x	x						
SO233-DR-43-10	1. Rock Type: volcanic 2. Size: 14x14x14 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 5. Texture / Vesicularity: ~ 10 % elongated vesicles (30 % filled) 6. Phenocrysts: ~ 5 % Plag (< 3 mm) 7. Matrix: fine grained 8. Secondary Minerals: green to yellow infilling in vesicles 9. Encrustations: Mn crust (1 - 2 mm)	x	x						

SO233-DR44

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, western margin. Elongated, E-W trending seamounts of the northwestern flank of the ridge, upper northern slope of the southernmost seamount.

Dredge on bottom	UTC 02/06/14 12:27hrs, lat 25°20.00'S, long 4°50.65'E, depth 2282m
Dredge off bottom	UTC 02/06/14 13:42hrs, lat 25°21.28'S, long 4°50.74'E, depth 1921m
total volume:	empty
Comments:	

SO233-DR45

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, western margin. Elongated, E-W trending seamounts of the northwestern flank of the ridge, middle section of the northern slope of the southernmost seamount, c. 3nm northeast of DR44.

Dredge on bottom	UTC 02/06/14 15:43hrs, lat 25°19.43'S, long 4°53.59'E, depth 2582m
Dredge off bottom	UTC 02/06/14 16:59hrs, lat 25°19.88'S, long 4°53.40'E, depth 2181m
total volume:	few rocks
Comments:	volcanics, volcaniclastic rocks, sedimentary rocks

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-45-1	1. Rock Type: volcanic 2. Size: 37x22x11 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: ~ 30 % vesicularity, porphyritic 6. Phenocrysts: ~ 3 % altered Ol (< 3 mm) 7. Matrix: fine grained 8. Secondary Minerals: vesicles filled with chalcedone ? and white material 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: altered glass rim, needs careful TS examination, matrix could be suitable for age dating	x	x	4	x				
SO233-DR-45-2	1. Rock Type: volcanic 2. Size: 9x9x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR44-1	x	x	4-5					
SO233-DR-45-3	1. Rock Type: volcaniclastic rock 2. Size: 18x13x8 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey 5. Texture / Vesicularity: subrounded clasts in unsorted matrix 9. Encrustations: Mn crust (1 - 3 cm) 10. Comment: few clasts separated, but too small (< 4 cm) and altered for further use								
SO233-DR-45-4-Mn	1. Rock Type: Mn crust 2. Size: 17x12x7 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: reddish - black								
SO233-DR-45-5-S	1. Rock Type: sediment (coral reef) 2. Size: 42x22x11 cm 3. Shape / Angularity: rounded 4. Color of cut surface: white 5. Texture / Vesicularity: vesicles (some tube-like in shape) in compact carbonate matrix 9. Encrustations: Mn crust (< 2 cm)					x			

SO233-DR46

Description of Location and Structure: Narrow central part of Walvis Ridge, northern section, western margin. Elongated, E-W trending seamounts of the northwestern flank of the ridge, lower northern slope of the central seamount.

Dredge on bottom	UTC 02/06/14 21:38hrs, lat 25°08.31'S, long 4°57.71'E, depth 3306m
Dredge off bottom	UTC 02/06/14 23:00hrs, lat 25°08.79'S, long 4°57.79'E, depth 2895m
total volume:	four rocks
Comments:	one volcanic pebble, solidified sediment

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-46-1	1. Rock Type: volcanic rock 2. Size: 18x10x8 cm 3. Shape / Angularity: round 4. Color of cut surface: brown 5. Texture / Vesicularity: porphyritic, 30 % vesicles 6. Phenocrysts: 15 % Ol (15 - 1 mm), 5 % Px (< 3 mm) 7. Matrix: fine grained 8. Secondary Minerals: some Cc vesicle fillings 9. Encrustations: Mn crust (3 mm)	x	x	5					
SO233-DR-46-2-S	1. Rock Type: pelagic sediment with thick Mn crust 2. Size: 20x18x10 cm 3. Shape / Angularity: subrounded 4. Color of surface: yellowish - white					x			

SO233-DR47

Description of Location and Structure: Broad central part of Walvis Ridge, sourthern section, western margin. Elongated, E-W trending seamounts of northwestern flank of the ridge, upper northern slope of the central seamount, c. 2.5nm southwest of DR46.

Dredge on bottom	UTC 03/06/14 01:54hrs, lat 25°10.26'S, long 4°55.51'E, depth 2538m
Dredge off bottom	UTC 03/06/14 03:08hrs, lat 25°10.71'S, long 4°55.51'E, depth 2157m
total volume:	one rock
Comments:	sedimentary carbonate crust with Mn crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-47-1-S	1. Rock Type: sedimentary carbonate crust with Mn crust 2. Size: 50x40x30 cm 3. Shape / Angularity: subangular 4. Color of surface: yellowish - white					x			

SO233-DR48

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, western margin. Elongated, E-W trending seamounts of northwestern flank of the ridge, upper northern slope of the northern seamount directly beneath crest.

Dredge on bottom	UTC 03/06/14 08:11hrs, lat 25°04.99'S, long 4°35.35'E, depth 2965m
Dredge off bottom	UTC 03/06/14 09:42hrs, lat 25°05.42'S, long 4°35.34'E, depth 2518m
total volume:	< half full
Comments:	volcanic, volcaniclastic rocks, sedimentary rocks (carbonates)

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-48-1	1. Rock Type: volcanic (clast) 2. Size: 24x12x10 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greyish - brown 5. Texture / Vesicularity: ~ 30 % vesicularity, amydules filled with Cc, Mn and chalcedone (40 %), porphyritic 6. Phenocrysts: ~2 % altered Ol (< 5 mm), ~ 10 % Plg needles (< 1 mm), 1 - 2 % Cpx (up to 5 mm) 7. Matrix: fine grained 8. Secondary Minerals: black material (Mn) 9. Encrustations: Mn crust (< 1 mm) 10. Comment: altered glass rim, volcanic clast?, needs careful TS examination, age dating possible, volcaniclastic matrix described in DR48-6	x	x	3?					
SO233-DR-48-2	1. Rock Type: volcanic (clast) 2. Size: 12x12x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greyish brown 10. Comment: similar to DR48-1, but vesicularity ~ 20 % (10 % filled), Plg (< 1 mm)	x	x	3?					
SO233-DR-48-3	1. Rock Type: volcanic (clast) 2. Size: 19x16x13 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 10. Comment: similar to DR48-1, but filled vesicles only 10 %, 10 % Plg (< 1 mm)	x	x	4?					
SO233-DR-48-4	1. Rock Type: volcanic (clast) 2. Size: 21x17x13 cm 3. Shape / Angularity: subangular 4. Color of cut surface: reddish brown 9. Encrustations: Mn crust (< 20 mm) 10. Comment: similar to DR48-1	x	x						
SO233-DR-48-5	1. Rock Type: volcanic (clast) 2. Size: 9x8x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: reddish brown 10. Comment: similar to DR48-1	x	x						
SO233-DR-48-6	1. Rock Type: volcaniclastic rock 2. Size: 38x21x20 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown to reddish clasts in white matrix 5. Texture / Vesicularity: angular to subangular clasts (10 - 20 cm ø) 10. Comment: separated clast (12x12x10 cm) similar to DR48-1, Cc veins	x	x						

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-48-7	1. Rock Type: volcaniclastic rock 2. Size: 38x21x20 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown - white 10. Comment: similar to DR48-6, separated clast 18x14x13 cm similar to DR48-1	x	x						
SO233-DR-48-8	1. Rock Type: volcaniclastic rock 2. Size: 28x18x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown - white 10. Comment: similar to DR48-6, separated clast 13x9x5 cm similar to DR48-1	x	x						
SO233-DR-48-9-X	10. Comment: archive sample similar to DR48-6								
SO233-DR-48-10-X	10. Comment: archive sample, fossil coral reef					x			

SO233-TV-MUC49

Description of Location and Structure: Abyssal plain off the northwestern flank of the southern broad central part of Walvis Ridge. Directly north of the northernmost E-W elongated seamount.

TV-MUC on bottom	UTC 03/06/14 13:25hrs, lat 24°56.70'S, long 4°32.63'E, depth 4655m
TV-MUC off bottom	UTC 03/06/14 13:25hrs, lat 24°56.82'S, long 4°32.65'E, depth 4647m
total volume:	empty
Comments:	all tubes washed out when MUC on deck

SO233-DR50

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, western margin. "Unexpected" small cone-shaped seamount on base of northwestern flank of the ridge.

Dredge on bottom	UTC 03/06/14 19:55hrs, lat 24°57.29'S, long 5°08.28'E, depth 3324m
Dredge off bottom	UTC 03/06/14 21:13hrs, lat 24°57.70'S, long 5°08.39'E, depth 2896m
total volume:	one rock
Comments:	sedimentary rock with Mn particles

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-50-1-S	1. Rock Type: sediment mixed with Mn particles 2. Size: 12x15x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown					x			

SO233-DR51

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, central area. Cliff at the western flank of the large massif in the center of the ridge (Valdivia Bank). Upper slope right beneath plateau edge.

Dredge on bottom UTC 04/06/14 06:21hrs, lat 25°10.92'S, long 5°41.05'E, depth 1540m
Dredge off bottom UTC 04/06/14 07:33hrs, lat 25°11.31'S, long 5°41.09'E, depth 1210m
total volume: few rocks
Comments: carbonates and corals

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-51-1-Mn	1. Rock Type: Mn crust 2. Size: 20x8x4 cm 3. Shape / Angularity: angular 4. Color of cut surface: black								
SO233-DR-51-2-S	1. Rock Type: sediment (coral reef) 2. Size: 18x12x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white					x			
SO233-DR-51-3-S	1. Rock Type: sediment (coral reef) 2. Size: 15x12x9 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white					x			

SO233-DR52

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, central area. Western flank of the large massif in the center of the ridge (Valdivia Bank), middle section of the slope, c. 3nm southwest of DR51.

Dredge on bottom UTC 04/06/14 09:14hrs, lat 25°12.55'S, long 5°39.36'E, depth 1587m
Dredge off bottom UTC 04/06/14 10:52hrs, lat 25°12.67'S, long 5°39.74'E, depth 1294m
total volume: few rocks
Comments: bridge took over at 10:20, carbonate sediments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-52-1-S	1. Rock Type: sediment (coral reef) 2. Size: 25x15x8 cm 3. Shape / Angularity: subrounded 4. Color of surface: white					x			

SO233-DR53

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Middle section of the northern slope of the huge seamount/guyot complex on the southeastern flank of the ridge.

Dredge on bottom	UTC 05/06/14 03:08hrs, lat 25°59.60'S, long 6°30.85'E, depth 2163m
Dredge off bottom	UTC 05/06/14 03:56hrs, lat 25°59.40'S, long 6°30.99'E, depth 1990m
total volume:	few rocks
Comments:	sedimentary rocks with Mn crust

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-53-1-Mn	1. Rock Type: Mn crust 2. Size: 18x12x5 cm 3. Shape / Angularity: angular 4. Color of surface: black								
SO233-DR-53-2-S	1. Rock Type: silty clay sediment 2. Size: 11x8x5 cm 3. Shape / Angularity: subrounded 4. Color of surface: yellowish-lightbrown 10. Comment: piece of a larger bloc					x			

SO233-DR54

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Upper southeastern slope of a conical seamount south of the huge seamount/guyot complex.

Dredge on bottom	UTC 05/06/14 15:58hrs, lat 26°32.08'S, long 6°13.24'E, depth 2877m
Dredge off bottom	UTC 05/06/14 17:00hrs, lat 26°32.28'S, long 6°13.60'E, depth 2446m
total volume:	few pieces
Comments:	few corals, stored at Naturkundemuseum Berlin

SO233-DR55

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Upper eastern slope of a conical seamount south of the huge seamount/guyot complex, c. 3nm NNW of DR54.

Dredge on bottom	UTC 05/06/14 20:47hrs, lat 26°29.54'S, long 6°11.62'E, depth 2459m
Dredge off bottom	UTC 05/06/14 21:58hrs, lat 26°29.74'S, long 6°11.98'E, depth 2169m
total volume:	few rocks
Comments:	carbonate crusts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-55-1-S	1. Rock Type: carbonate with Mn crust 2. Size: 25x12x6 cm 3. Shape / Angularity: subangular 4. Color of surface: black and white					x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-55-2-S	1. Rock Type: sediment (fossil coral reef) 2. Size: 15x10x8 cm 3. Shape / Angularity: subangular 4. Color of surface: grey - black					x			

SO233-DR56

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Small step in northwestern top region of the huge seamount/guyot complex on the southeastern flank of the ridge.

Dredge on bottom	UTC 06/06/14 06:51hrs, lat 26°19.93'S, long 6°07.12'E, depth 1254m
Dredge off bottom	UTC 06/06/14 07:30hrs, lat 26°20.04'S, long 6°07.12'E, depth 1063m
total volume:	empty
Comments:	

SO233-TVG57

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Upper southwestern slope of the huge seamount/guyot complex on the southeastern flank of the ridge, across small NE-SW trending extension beneath plateau edge.

TVG on bottom	UTC 06/06/14 12:20hrs lat 26°18.14'S long 6°26.40'E depth 1517m
TVG off bottom	UTC 06/06/14 14:07hrs lat 26°18.40'S long 6°26.90'W depth 1666m
total volume:	full
Comments:	sandy sediment consisting of forams; few rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-TVG-57-1	1. Rock Type: volcanic 2. Size: 17x11x11 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown with altered part more reddish brown 5. Texture / Vesicularity: 5 % vesicles mostly open and some filled with white material (Cc, 2 %) 6. Phenocrysts: 3 % Ol (< 5 mm), altered phenocrysts (Cpx), black minerals 7. Matrix: fine grained 8. Secondary Minerals: Cc filling vesicles 9. Encrustations: Mn crust (1 - 2 mm)	x	x						
SO233-TVG-2-X	1. Rock Type: volcanic 2. Size: 6x5.5x4 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brown 5. Texture / Vesicularity: highly vesicular, vesicles up to 1 cm, mostly filled with Cc (40 %) 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: Cc filling vesicles								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-TVG-57-3	1. Rock Type: volcaniclastic rock 2. Size: 14x6x4 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown to red, clasts brown, red matrix 5. Texture / Vesicularity: porphyritic 6. Phenocrysts: 2-3 % Plg, phenocrysts which cannot be determined 7. Matrix: fine grained 8. Secondary Minerals: fine Cc veins 9. Encrustations: Mn crust (1-2 mm)								
SO233-TVG-4-X	1. Rock Type: volcaniclastic rock 2. Size: 19x12x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish-yellow 5. Texture / Vesicularity: porphyritic, vesicles in clasts, mostly open 6. Phenocrysts: aphyric 7. Matrix: medium to coarse grained 8. Secondary Minerals: Cc in veins between interstices 9. Encrustations: Mn crust (1 mm)								
SO233-TVG-57-5-X	1. Rock Type: carbonate sediment 2. Size: 21x14x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white					x			
SO233-TVG-57-6	1. Rock Type: sediment, highly altered 2. Size: 24x11x17 cm 3. Shape / Angularity: subangular 4. Color of cut surface: orange-brown					x			
SO233-TVG-57-7	1. Rock Type: volcanic 2. Size: 5x5x3 cm 3. Shape / Angularity: angular 4. Color of cut surface: black 5. Texture / Vesicularity: no vesicles 6. Phenocrysts: black Px sub-phenocrysts, altered Ol, white Plg needles (?) 7. Matrix: fine grained 10. Comment: needs careful TS examination and could be suitable for age dating	x		4					

Appendix II: SO-233 Rock Description

SO233-DR58

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Middle section of the southeastern slope of ridge-like feature extending to the south from the huge seamount/guyot complex on the southeastern flank of the ridge.

Dredge on bottom	UTC 06/06/14 21:41hrs, lat 26°23.26'S, long 6°29.71'E, depth 3216m
Dredge off bottom	UTC 06/06/14 22:32hrs, lat 26°23.25'S, long 6°30.04'E, depth 3012m
total volume:	empty
Comments:	

SO233-DR59

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Northwestern slope of small cone (from base to top) SSE of the southeastern slope of ridge-like extension from the huge seamount/guyot complex, c. 5nm SSE of DR58.

Dredge on bottom	UTC 07/06/14 01:27hrs, lat 26°28.42'S, long 6°27.56'E, depth 3530m
Dredge off bottom	UTC 07/06/14 02:48hrs, lat 26°28.51'S, long 6°28.16'E, depth 3085m
total volume:	2 rocks
Comments:	volcanic rock and biogenic carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-59-1	1. Rock Type: volcanic rock 2. Size: 19x8x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white - brownish - grey 5. Texture / Vesicularity: porphyritic, > 50 % vesicles, mostly filled 6. Phenocrysts: 15 % Px (< 3 mm), 10 % Ol (< 2 mm), 5 % Plg (< 2 mm), all phenocrysts completely altered 7. Matrix: fine grained 8. Secondary Minerals: white and brown vesicle fillings 9. Encrustations: very thin Mn crust 10. Comment: matrix appears quite fresh and could be used for age dating	x	x	3 (G m)					
SO233-DR-59-2	1. Rock Type: biogenic carbonate (shell?) 2. Size: 17x14x6 cm 3. Shape / Angularity: subrounded 4. Color of surface: white 10. Comment: made up of layers of shell, stored at Naturkundemuseum Berlin								

SO233-DR60

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Lower southwestern slope of the huge seamount/guyot complex, beneath station TVG57.

Dredge on bottom	UTC 07/06/14 06:02hrs, lat 26°20.82'S, long 6°24.56'E, depth 2528m
Dredge off bottom	UTC 07/06/14 07:10hrs, lat 26°20.82'S, long 6°24.93'E, depth 2226m
total volume:	2 rocks
Comments:	volcanic rocks

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-60-1	1. Rock Type: volcanic, altered 2. Size: 12x10x6 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: greyish - black 5. Texture / Vesicularity: ~ 45 % vesicularity (90 % filled), porphyritic 6. Phenocrysts: ~ 15 % altered Ol (< 7 mm) 7. Matrix: fine grained 8. Secondary Minerals: Cc filling vesicles 9. Encrustations: Mn crust (< 2 mm), transparent mineral assemblage on surface	x	x						
SO233-DR-60-2	1. Rock Type: volcanic 2. Size: 8x7x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey - black 10. Comment: similar to DR60-1								

SO233-DR61

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Lower wall-like slope of a deep canyon cutting into the eastern flank of the ridge, extremely steep slope.

Dredge on bottom	UTC 07/06/14 13:46hrs, lat 25°52.43'S, long 6°36.50'E, depth 3736m
Dredge off bottom	UTC 07/06/14 15:57hrs, lat 25°52.50'S, long 6°36.58'E, depth 3684m
total volume:	empty
Comments:	bridge took over at 3600m rope length

SO233-DR62

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Base of a wall-like slope of a deep canyon cutting into the eastern flank of the ridge. Dredge track oblique to the slope.

Dredge on bottom	UTC 07/06/14 19:24hrs, lat 25°51.05'S, long 6°36.33'E, depth 3765m
Dredge off bottom	UTC 07/06/14 20:49hrs, lat 25°51.01'S, long 6°36.81'E, depth 3318m
total volume:	2 rocks
Comments:	fresh volcanic rock and volcaniclastica with glass particles

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-62-1	1. Rock Type: volcanic rock, fresh 2. Size: 13x12x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: fine grained, < 1 % filled vesicles and alteration cracks, porphyritic 6. Phenocrysts: 1 - 2 % white Plg needles (< 1 mm), 1 - 2 % black Px needles (< 1mm), 1 % altered Ol (< 1 mm) 7. Matrix: fine grained, dense 8. Secondary Minerals: along cracks and in vesicles, white to greenish color 9. Encrustations: no Mn crust 10. Comment: fairly fresh, fine grained basalt	x	x	2					

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-62-2	1. Rock Type: volcaniclastic glass particles 2. Size: 8x5x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey, altered parts brown 5. Texture / Vesicularity: rounded glass clasts (mm to cm ø) in altered palagonite (hyaloclastite) 6. Phenocrysts: white Plg needles (< 1 mm) 7. Matrix: dense, fine grained (glass clasts) 8. Secondary Minerals: palagonite rims around class clasts 9. Encrustations: partly very thin Mn crust 10. Comment: altered hyaloclastite with fresh glass	x		1	Gl				

SO233-DR63

Description of Location and Structure: Broad central part of Walvis Ridge, southern section, eastern margin. Lower wall-like slope of a deep canyon cutting into the eastern flank of the ridge. Repetition of dredge haul DR61 but only the uppermost part.

Dredge on bottom	UTC 07/06/14 23:30hrs, lat 25°52.59'S, long 6°36.54'E, depth 3400m
Dredge off bottom	UTC 08/06/14 00:27hrs, lat 25°52.77'S, long 6°36.64'E, depth 3106m
total volume:	empty
Comments:	

SO233-DR64

Description of Location and Structure: Broad central part of Walvis Ridge, central section, eastern margin. Lower steep slope of a small, less distinct canyon cutting into the eastern flank of the ridge, c. 30nm NNE of DR61-63.

Dredge on bottom	UTC 08/06/14 06:40hrs, lat 25°21.79'S, long 6°43.26'E, depth 2930m
Dredge off bottom	UTC 08/06/14 08:06hrs, lat 25°21.90'S, long 6°43.20'E, depth 2720m
total volume:	four rocks
Comments:	volcanic rocks; bridge took over at 2724m rope length

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-64-1	1. Rock Type: volcanic 2. Size: 16x15x11 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown (gradual change from darker rim to lighter core) 5. Texture / Vesicularity: porphyritic 6. Phenocrysts: ~ 10 % altered and replaced Ol (< 3 mm), ~ 7 % Plg needles (< 1 mm), ~ 5 % Cpx (diopside?, ~ 1 mm) 7. Matrix: fine grained 8. Secondary Minerals: Cc and iddingsite (former Ol) 10. Comment: Cc vein network with dark rims (Mn?), TS examination to clarify if Plg is still fresh and suitable for age dating	x	x	4-5					
SO233-DR64-2	1. Rock Type: volcanic 2. Size: 10x10x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown grading of color from reddish - brown rim to brown core 10. Comment: similar to DR64-1, but phenocrysts < 2 mm and Ol < 5 %, near rim black (fresh ?) spots	x	x	4-5					

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-64-3	1. Rock Type: volcanic 2. Size: 7x7x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 10. Comment: similar to DR64-2								
SO233-DR-64-4	1. Rock Type: volcanic 2. Size: 13x12x3 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown 10. Comment: similar to DR64-2, but has the biggest black (fresh ?) areas	x							

SO233-TV-MUC65

Description of Location and Structure: Broad central part of Walvis Ridge, central section, plain on eastern region, c.100nm north of DR64.

TV-MUC on bottom	UTC 08/06/14 17:55hrs, lat 23°55.81'S, long 6°45.32'E, depth 2861m
TV-MUC off bottom	UTC 08/06/14 17:57hrs, lat 23°55.80'S, long 6°45.32'E, depth 2861m
total volume:	3 tubes
Comments:	soft sediment and bottom water, water analyses O_2 40.6 % , pH 7.81 and salt content 3.39 %

SO233-DR66

Description of Location and Structure: Northern part of Walvis Ridge, southeastern section, eastern margin. Upper slope at southern tip of N-S trending extension (volcanic rift) from large guyot on eastern margin.

Dredge on bottom	UTC 09/06/14 11:53hrs, lat 22°42.66'S, long 7°34.25'E, depth 3871m
Dredge off bottom	UTC 09/06/14 13:04hrs, lat 22°42.90'S, long 7°34.62'E, depth 3551m
total volume:	few rocks
Comments:	volcanics, volcaniclastic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-66-1	1. Rock Type: volcanic (fresh) 2. Size: 14x10x7 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: ~ 15 % vesicularity (~ 10 % filled), porphyritic 6. Phenocrysts: 2 - 3 % altered Ol (< 5 mm) 7. Matrix: fine grained, fresh (Px and Fsp) 8. Secondary Minerals: greenish vesicles filling (chalcedone) 9. Encrustations: Mn crust (< 5 mm) 10. Comment: matrix is suitable for age dating	x	x	2-3					
SO233-DR-66-2	1. Rock Type: volcanic (fresh) 2. Size: 15x10x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: vesicularity ~ 7 % (90 % filled), porphyritic 6. Phenocrysts: 2 - 3 % altered Ol (2 - 3 mm) 7. Matrix: fine grained (Px and Fsp) 8. Secondary Minerals: green to yellow material in vesicles 9. Encrustations: Mn crust (< 6 mm) 10. Comment: matrix is suitable for age dating	x	x	2-3					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-66-3	1. Rock Type: volcanic (fresh) 2. Size: 14x7x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR66-2, but ~ 10 % vesicularity (50 % filled) and encrustation < 2 mm	x	x	2-3					
SO233-DR-66-4	1. Rock Type: volcaniclastic rock (highly altered pyroclastic sediment ?) 2. Size: 9x9x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white to green 5. Texture / Vesicularity: green clasts in white matrix								

SO233-DR67

Description of Location and Structure: Central Walvis Ridge, eastern part. Northern slope of a guyot.

Dredge on bottom	UTC 10/06/14 08:36hrs, lat 22°22.05'S, long 7°30.13'E, depth 2235m
Dredge off bottom	UTC 10/06/14 --:--hrs, lat --°--.--'S, long --°--.--'E, depth ----m
total volume:	
Comments:	dredge and 400m rope lost at 13:20hrs by 13.5t rope tension

SO233-DR68

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, guyot on plain just west of eastern margin. Middle section of northern slope of the guyot. First dredge attempt at that site.

Dredge on bottom	UTC 11/06/14 14:03hrs, lat 22°27.57'S, long 6°50.26'E, depth 2408m
Dredge off bottom	UTC 11/06/14 15:13hrs, lat 22°28.02'S, long 6°50.33'E, depth 2105m
total volume:	empty
Comments:	

SO233-DR69

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, guyot on plain just west of eastern margin. Middle section of northern slope of the guyot, < 1 nm west of DR68. Second dredge attempt at that site.

Dredge on bottom	UTC 11/06/14 17:18hrs, lat 22°28.21'S, long 6°48.95'E, depth 2246m
Dredge off bottom	UTC 11/06/14 18:24hrs, lat 22°28.59'S, long 6°49.14'E, depth 1946m
total volume:	few rocks
Comments:	carbonate crusts, dredge catched its chain bag

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-69-1-X	1. Rock Type: carbonate crust (fossil coral reef) 2. Size: 26x19x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white to yellowish 9. Encrustations: Mn crust (~ 1 mm)								

SO233-DR70

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, guyot on plain just west of eastern margin. Middle section of northern slope of the guyot, repetition of DR68. Third dredge attempt at that site.

Dredge on bottom	UTC 11/06/14 21:10hrs, lat 22°27.68'S, long 6°50.20'E, depth 2589m
Dredge off bottom	UTC 11/06/14 22:34hrs, lat 22°28.13'S, long 6°50.31'E, depth 1944m
total volume:	empty
Comments:	eye of dredge brocken

SO233-DR71

Description of Location and Structure: Northern part of Walvis Ridge,southwestern section, western margin. Lower western slope of a N-S elongated guyot-like feature on the western flank of the ridge.

Dredge on bottom	UTC 12/06/14 09:44hrs, lat 22°39.80'S, long 5°07.30'E, depth 3115m
Dredge off bottom	UTC 12/06/14 11:22hrs, lat 22°39.90'S, long 5°07.43'E, depth 2979m
total volume:	2 rocks
Comments:	one volcaniclastic rock and one volcanic rock

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-71-1	1. Rock Type: volcanic, highly altered 2. Size: 12x7x4 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown 5. Texture / Vesicularity: ~ 5 % vesicularity, vesicles filled with Mn, porphyritic 6. Phenocrysts: ~ 7 % altered Ol (< 3 mm), < 1 % Cpx (< 1 mm) 7. Matrix: fine grained, ~ 50 % small Plg needles 8. Secondary Minerals: iddingsite (former Ol) 9. Encrustations: Mn crust (< 1 mm) 10. Comment: TS examination to clarify if Plg is still fresh or not for age dating	x	x	?					
SO233-DR-71-2	1. Rock Type: volcaniclastic rock (conglomerate, highly altered) 2. Size: 10x7x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown to greenish - yellow clast in transparent groundmass 5. Texture / Vesicularity: different degrees of highly altered volcanic clasts (up to 5 cm) in Cc groundmass, smallest clasts are more altered, clasts are similar to DR71-1 9. Encrustations: Mn crust (< 2 mm)								

SO233-DR72

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, western margin. Middle section of the western slope of a N-S elongated guyot-like feature on the western flank of the ridge, c. 3nm north of DR71.

Dredge on bottom	UTC 12/06/14 15:16hrs, lat 22°36.90'S, long 5°07.00'E, depth 3020m
Dredge off bottom	UTC 12/06/14 16:37hrs, lat 22°37.20'S, long 5°07.37'E, depth 2687m
total volume:	one rock
Comments:	volcaniclastic rock

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-72-1	1. Rock Type: volcaniclastic rock 2. Size: 10x7x5 cm 3. Shape / Angularity: angular 4. Color of cut surface: brown clasts in white matrix Cc 5. Texture / Vesicularity: the big clasts are similar to DR71-1, but slightly more altered and contain ~ 5 % Ol 9. Encrustations: Mn crust (< 1 mm) 10. Comment: Mn in vesicles								

SO233-DR73

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, western margin. Upper slope of small seamount situated right above the western flank of the ridge, c. 11.5nm north of DR72.

Dredge on bottom	UTC 12/06/14 20:47hrs, lat 22°25.65'S, long 5°06.21'E, depth 3350m
Dredge off bottom	UTC 12/06/14 21:54hrs, lat 22°25.87'S, long 5°06.55'E, depth 3074m
total volume:	empty
Comments:	

SO233-DR74

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, western margin. Base of western flank beneath large seamount right above the ridge margin, c. 12nm north of DR73.

Dredge on bottom	UTC 13/06/14 02:39hrs, lat 22°13.92'S, long 5°03.31'E, depth 3801m
Dredge off bottom	UTC 13/06/14 03:28hrs, lat 22°14.16'S, long 5°03.32'E, depth 3584m
total volume:	one rock
Comments:	highly altered volcanic rock

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-74-1	1. Rock Type: volcanic, highly altered 2. Size: 7x5x4 cm 3. Shape / Angularity: subangular 4. Color of cut surface: orange-brown 5. Texture / Vesicularity: porphyritic, no primary vesicles 6. Phenocrysts: 20 % Ol (0.5 - 4 mm), completely replaced by secondary minerals 7. Matrix: fine - medium grained, dominated by Fsp 8. Secondary Minerals: pervasive Mn alteration, mainly along vein fractures 9. Encrustations: thin Mn crust (~ 1 mm) 10. Comment: parts appear fresher (towards the conic end). Needs careful picking.	x	?						

SO233-DR75

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, western margin. Steep, wall-like slope (from base to top) of a small canyon cutting into the western margin of the ridge, c. 9nm north of DR74.

Dredge on bottom	UTC 13/06/14 09:36hrs, lat 22°04.48'S, long 5°06.09'E, depth 4106m
Dredge off bottom	UTC 13/06/14 10:56hrs, lat 22°04.79'S, long 5°06.19'E, depth 3578m
total volume:	less than half full
Comments:	volcanic rocks

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-75-1	1. Rock Type: volcanic (pillow basalt) 2. Size: 43x35x18 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: ~ 15 % vesicularity (~ 80 % filled), aphyric 6. Phenocrysts: aphyric 7. Matrix: fine grained, fresh Plg needles, altered Ol 8. Secondary Minerals: Cc vesicles filling, green clay ? vesicles filling 9. Encrustations: Mn crust (< 1 mm) 10. Comment: part of bloc E, matrix suitable for age dating	x	x	1-2					
SO233-DR-75-2	1. Rock Type: volcanic (pillow basalt) 2. Size: 40x25x17 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: part of bloc F, similar to DR75-1, but vesicularity ~ 50 % (50 % filled)	x	x						
SO233-DR-75-3	1. Rock Type: volcanic (pillow basalt) 2. Size: 20x10x10 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR75-2	x	x						
SO233-DR-75-4	1. Rock Type: volcanic (pillow basalt) 2. Size: 24x16x14 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: simiar to DR75-2, but ~ 25 % vesicularity (30 % filled with Cc, 35 % with green material)	x	x						
SO233-DR-75-5	1. Rock Type: volcanic (pillow basalt) 2. Size: 15x12x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey 10. Comment: similar to DR75-2	x	x						
SO233-DR-75-6	1. Rock Type: volcanic (Ol basalt) 2. Size: 12x11x10 cm 3. Shape / Angularity: angular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: ~ 30 % vesicularity (45 % filled), porphyritic 6. Phenocrysts: ~ 7 % altered Ol (< 1 - 2 mm) 7. Matrix: fine grained, Plg and Cpx ? 8. Secondary Minerals: Cc and green material vesicles filling 9. Encrustations: Mn crust patchy (< 1 mm) 10. Comment: groundmass is suitable for age dating	x	x	2-3 (Gm)					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-75-7	1. Rock Type: volcanic (brecciated Ol basalt) 2. Size: 18x18x14 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR78-6, peperite, fresh green minerals (Cpx) in altered Ol	x	x						
SO233-DR-75-8	1. Rock Type: volcanic (Ol basalt pillow) 2. Size: 21x15x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR75-6, vesicles are somewhat larger, Cc veins	x	x						
SO233-DR-75-9	1. Rock Type: volcanic (Ol basalt) 2. Size: 17x16x7 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR75-8 but Ol < 10 mm, fresh Cpx crystal intergrowth with Ol, careful examination	x	x						
SO233-DR-75-10	1. Rock Type: volcanic (Ol basalt) 2. Size: 20x16x6 cm 3. Shape / Angularity: angular - tabular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR75-6, possible to separate a second GC bloc	x	x						
SO233-DR-75-11	1. Rock Type: volcanic (Ol basalt) 2. Size: 18x14x4 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey - black 10. Comment: similar to DR75-9, but but highly vesicular (~ 50 %, up to 1 mm) and interlinked	x	x						
SO233-DR-75-12	1. Rock Type: volcaniclastic rock 2. Size: 22x13x7 cm 3. Shape / Angularity: rounded 4. Color of cut surface: brownish - reddish - grey 5. Texture / Vesicularity: built up by unsorted, brown, highly altered volcanic clasts								
SO233-DR-75-13	1. Rock Type: volcaniclastic rock 2. Size: 18x8x4 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brownish white 5. Texture / Vesicularity: white soft groundmass with few highly altered volcanic clasts (up to 3 cm)								
SO233-DR-75-14-X to -25-X	10. Comment: archive samples for additional informations, e.g., if the geochemical data indicate several volcanic stages								

Appendix II: SO-233 Rock Description

SO233-TV-MUC76

Description of Location and Structure: Abyssal plain north of the northwestern margin of the northern part of the Walvis Ridge. Inbetween northwestern margin and the isolated seamounts off the margin.

TV-MUC on bottom	UTC 13/06/14 16:28hrs, lat 21°35.99'S, long 5°01.32'E, depth 4463m
TV-MUC off bottom	UTC 13/06/14 16:30hrs, lat 21°35.99'S, long 5°01.32'E, depth 4463m
total volume:	2 tubes
Comments:	soft sediment and bottom water, water analyses O_2 40.5 % , pH 7.8 and salt content 3.34 %

SO233-DR77

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, western one of the two isolated guyots to the north of the ridge. Middle section of the southern slope.

Dredge on bottom	UTC 14/06/14 01:13hrs, lat 21°12.93'S, long 5°04.13'E, depth 3273m
Dredge off bottom	UTC 14/06/14 02:33hrs, lat 21°12.90'S, long 5°03.63'E, depth 2972m
total volume:	three rocks
Comments:	volcanic rocks (pillow lava)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-77-1	1. Rock Type: volcanic, moderately altered 2. Size: 35x21x18 cm 3. Shape / Angularity: angular pillow fragment 4. Color of cut surface: brownish - grey with white and brown spots 5. Texture / Vesicularity: highly vesicular with 60 % fillings 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: Cc and red vesicle fillings 9. Encrustations: Mn crust (~ 1 cm) 10. Comment: pillow fragment from bloc H; some altered glass rim fragments taken as archive	x	x						
SO233-DR-77-2	1. Rock Type: volcanic, similar to DR77-1 but slightly more altered 2. Size: 20x20x16 cm 3. Shape / Angularity: angular pillow fragment 4. Color of cut surface: brownish - grey with white and brown spots 5. Texture / Vesicularity: highly vesicular with 60 % fillings 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: Cc, Ol? 9. Encrustations: Mn crust (~ 1 cm) 10. Comment: pillow fragment from bloc N; probably same flow as DR77-1	x	x						
SO233-DR-77-3	1. Rock Type: volcanic, highly altered 2. Size: 9x6x6 cm 3. Shape / Angularity: angular pillow fragment 4. Color of cut surface: brown 10. Comment: similar to DR77-1 but more altered; some vesicles could be former Ol phenocrysts ??								
SO233-DR-77-1-A	1. Rock Type: pillow rim fragments with semi-altered glass from DR77-1 10. Comment: maybe some fresh parts ? Attention: still some Mn crust on top of some pieces				Gl				

Appendix II: SO-233 Rock Description

SO233-TVG78

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, eastern one of the two isolated guyots to the north of the ridge. Upper southern slope c. 350 m beneath plateu edge, on top of small "noose" or extension.

TVG on bottom	UTC 14/06/14 12:13hrs, lat 20°09.45'S, long 5°59.07'E, depth 2152 / 2157m
TVG off bottom	UTC 14/06/14 13:58hrs, lat 20°10.19'S, long 5°59.09'E, depth 2163 / 2147m
total volume:	empty
Comments:	3x failed to grab sediment or rocks, battery empty

SO233-TVG79

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, eastern one of the two isolated guyots to the north of the ridge. Upper southern slope c. 350 m beneath plateu edge, on top of small "noose" or extension. Repetition of TVG78, same position as end of TVG78.

TVG on bottom	UTC 14/06/14 15:40hrs, lat 20°10.19'S, long 5°59.09'E, depth 2160m
TVG off bottom	UTC 14/06/14 15:47hrs, lat 20°10.19'S, long 5°59.09'E, depth 2173m
total volume:	some benthos
Comments:	corals, echinodermata, crustacea, mollusca (no sediment or rocks!)

SO233-DR80

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, eastern one of the two isolated guyots to the north of the ridge. Upper slope right beneath top of a cone-like feature at the southwestern base of the guyot.

Dredge on bottom	UTC 14/06/14 19:20hrs, lat 20°12.70'S, long 5°55.53'E, depth 3608m
Dredge off bottom	UTC 14/06/14 20:40hrs, lat 20°13.15'S, long 5°55.56'E, depth 3200m
total volume:	four rocks
Comments:	volcanic rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-80-1	1. Rock Type: volcanic, relatively fresh 2. Size: 8x6x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: 10 % vesicles, partly filled with Cc and zeolites 6. Phenocrysts: 20 % Plg microphenocrysts (~ 1 mm) 7. Matrix: fine grained 8. Secondary Minerals: Cc and zeolites in vesicles 9. Encrustations: Mn crust (< 1 mm) 10. Comment: vesicles are elongated ("pipe vesicles")	x	x	2					
SO233-DR-80-2	1. Rock Type: volcanic, altered 2. Size: 15x13x12 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: orange-brown 5. Texture / Vesicularity: porphyritic, 35 % vesicles, some filled 6. Phenocrysts: 10 % Ol (0.5 - 3 mm), completely altered 7. Matrix: very fine grained 8. Secondary Minerals: Mn and Cc in vesicles, likely phyllosilicates in matrix 9. Encrustations: Mn crust (2 mm) 10. Comment: rock contains darker (fresher?) parts as irregular "Schlieren", GC pieces preferentially contain these "Schlieren". Need to be picked out of orange (more altered (? check TS!) surrounding material	x	x						

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-80-3	1. Rock Type: volcanic, altered 2. Size: 40x20x20 cm 3. Shape / Angularity: angular to sub-spherical 4. Color of cut surface: orange-brown 10. Comment: similar to DR80-2; large bloc H; GC pieces contain more darker Schlieren-material than DR80-2 GC. Maybe better for picking?	x	x						
SO233-DR-80-4	1. Rock Type: volcanic, highly altered 2. Size: 15x13x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brown 10. Comment: similar to DR80-2. This seems to be the most altered rock and contains less "Schlieren"								

SO233-TV-MUC81

Description of Location and Structure: Abyssal plain right off the northwestern margin of the southwestern section of the northern part of Walvis Ridge.

TV-MUC on bottom	UTC 15/06/14 06:11hrs, lat 20°26.92'S, long 7°11.73'E, depth 4346m
TV-MUC off bottom	UTC 15/06/14 06:13hrs, lat 20°26.92'S, long 7°11.73'E, depth 4345m
total volume:	6 tubes
Comments:	soft sediment and bottom water, water analyses O_2 40.3 % , pH 7.78 and salt content 3.33 %

SO233-DR82

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, northwestern margin. Close to western termination of the steep northern scarp, lower slope.

Dredge on bottom	UTC 15/06/14 11:47hrs, lat 20°29.10'S, long 7°20.32'E, depth 4213m
Dredge off bottom	UTC 15/06/14 13:07hrs, lat 20°29.55'S, long 7°20.36'E, depth 3720m
total volume:	less than half full
Comments:	unconsolidated to slightly consolidated sediments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-82-1-S	1. Rock Type: sediment (pelitic sediment) 2. Size: 9x6x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white 10. Comment: slightly consolidated					x			
SO233-DR-82-2-S	1. Rock Type: sediment (pelitic sediment) 2. Size: 15x11x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: white - grey 10. Comment: unconsolidated					x			

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-82-3-S	1. Rock Type: sediment (pelitic sediment) 2. Size: 27x9x5 cm 3. Shape / Angularity: round, oval 4. Color of cut surface: grey 5. Texture / Vesicularity: foliation of clay minerals 10. Comment: small clast / particles in sediment					x			
SO233-DR-82-4-S	1. Rock Type: sediment (pelitic sediment) 2. Size: 15x11x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - white					x			
SO233-DR-82-5-S	1. Rock Type: sediment (pelitic sediment) 2. Size: 20x15x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey 5. Texture / Vesicularity: foliation of clay minerals 10. Comment: small clast in sediment					x			
SO233-DR-82-6-S	1. Rock Type: sediment (pelitic sediment) 2. Size: 16x13x7 cm 3. Shape / Angularity: angular 4. Color of cut surface: greenish - white					x			

SO233-DR83

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, northwestern margin. Western section of the steep northern scarp, lower slope of a small canyon cutting into the margin, c. 9nm east of DR82.

Dredge on bottom	UTC 15/06/14 17:52hrs, lat 20°23.51'S, long 7°28.25'E, depth 4531m
Dredge off bottom	UTC 15/06/14 19:12hrs, lat 20°23.87'S, long 7°28.34'E, depth 4000m
total volume:	empty
Comments:	

SO233-DR84

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, northwestern margin. Western section of the steep northern scarp, upper eastern slope of a canyon or slumping structure c. 10nm east of DR83.

Dredge on bottom	UTC 16/06/14 01:04hrs, lat 20°20.37'S, long 7°38.12'E, depth 3794m
Dredge off bottom	UTC 16/06/14 02:12hrs, lat 20°20.62'S, long 7°38.38'E, depth 3409m
total volume:	few rocks
Comments:	volcanic rocks, consolidated sediment, chert in sediment

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-84-1	1. Rock Type: volcanic, moderately altered 2. Size: 10x7x5 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey - brown 5. Texture / Vesicularity: porphyritic, no vesicles 6. Phenocrysts: ~ 20% altered Plg (albitic ?; up to 4 mm), ~ 5% black minerals (Px or ore ?; < 1mm) 7. Matrix: fine grained with many relatively fresh Fsp-needles **8. Secondary minerals: none** 9. Encrustations: very thin Mn crust (< 0.5 mm) 10. Comment: groundmass Fsp possibly suitable for age dating, Plg phenocrysts also suitable ?, careful TS examination	x	x	3					
SO233-DR-84-2	1. Rock Type: volcanic, moderately altered 2. Size: 16x9x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey - dark brown 5. Texture / Vesicularity: porphyritic, ~ 15 % vesicularity (filled with Mn and other secondary minerals in center) 6. Phenocrysts: 25 - 30 % altered Plg (< 1 cm), 3 - 5 % reddish - brown minerals (Px or Ol?) 7. Matrix: fine grained 8. Secondary Minerals: Mn 9. Encrustations: Mn crust (~ 1 mm) 10. Comment: unclear if Plg phenocrysts are suitable for age dating	x	x	?					
SO233-DR-84-3	1. Rock Type: volcanic, strongly altered 2. Size: 11x9x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey with black and white spots 10. Comment: similar to DR84-2 but < 1 % reddish - brown minerals	x							
SO233-DR-84-4	1. Rock Type: volcanic, strongly altered 2. Size: 9x7x6 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey with black and light spots 10. Comment: similar to DR84-2, but larger filled vesicles and < 3 % reddish - brown minerals	x							
SO233-DR-84-5	1. Rock Type: chert in sediment 2. Size: 7x7x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: yellowish - grey 5. Texture / Vesicularity: dense, amorph 10. Comment: Mn crust (< 3 mm)								
SO233-DR-84-6-S	1. Rock Type: consolidated sediment 2. Size: 12x8x6 cm 3. Shape / Angularity: subangular 4. Color of surface: yellow - white 9. Encrustations: Mn crust < 1 mm					x			

SO233-DR85

Description of Location and Structure: Northern part of Walvis Ridge, southwestern section, northwestern margin. Western section of the steep northern scarp, upper eastern slope of a canyon right beneath a seamount on top of the margin, c. 6nm east of DR84.

Dredge on bottom	UTC 16/06/14 07:32hrs, lat 20°17.50'S, long 7°44.06'E, depth 4150m
Dredge off bottom	UTC 16/06/14 08:45hrs, lat 20°17.57'S, long 7°44.44'E, depth 3714m
total volume:	empty
Comments:	

SO233-TVG86

Description of Location and Structure: Northern part of Walvis Ridge, northeastern section, large guyot on southern margin. Southern area of top plateau.

TVG on bottom	UTC 16/06/14 16:52hrs, lat 20°42.24'S, long 8°41.11'E, depth 354m
TVG off bottom	UTC 16/06/14 17:15hrs, lat 20°47.24'S, long 8°41.13'E, depth 345m
total volume:	full
Comments:	Carbonate and calcaceous sediments consisting of shell fragments

SO233-DR87

Description of Location and Structure: Northern part of Walvis Ridge, northeastern section, large guyot on southern margin. Steep step in the northern slope beneath top plateau.

Dredge on bottom	UTC 16/06/14 21:57hrs, lat 20°38.61'S, long 8°37.69'E, depth 1848m
Dredge off bottom	UTC 16/06/14 23:25hrs, lat 20°39.01'S, long 8°37.93'E, depth 1330m
total volume:	more than half full
Comments:	volcanic rocks, breccia, Mn crusts, sediments, biology; at least four different lithologies: 1. DR87-1 and -2, 2. DR87-3, 3. DR87-4, 4. DR87-5 to -12

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-87-1	1. Rock Type: volcanic, moderately altered 2. Size: 12x8x8 cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: dense (< 1 % vesicles) 6. Phenocrysts: < 1 % Plg (?) phenocrysts (< 2 mm), well preserved 7. Matrix: fine grained 8. Secondary Minerals: Mn along veins, Cc in vesicles 9. Encrustations: thin Mn crust (< 1 mm) 10. Comment: attention: GC piece contains brecciated material at one side. Needs to be removed before further crushing! Mn migrates like dendrites from veins into fresh rock	x	x	3 (G m)					
SO233-DR-87-2	1. Rock Type: volcanic, moderately altered 2. Size: 10x8x6 cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: light-brown 5. Texture / Vesicularity: dense (< 1 % vesicles), porphyritic 6. Phenocrysts: 15 % Fsp (< 3 mm), well preserved 7. Matrix: fine grained 8. Secondary Minerals: phyllosilicates (orange) in rare voids 9. Encrustations: thin Mn crust (< 0.5 mm) 10. Comment: Fsp well suitable for age dating!	x	x	2	Fsp				

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-87-3	1. Rock Type: breccia containing volcanic clasts (3-A to 3-D + archive) cemented by pelagic sediment and Mn 2. Size: 40x20x30 cm (breccia) 3. Shape / Angularity: angular to subangular clasts (2 - 10 cm Ø) 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: dense (< 1 % vesicles) 6. Phenocrysts: < 3 % Fsp (well preserved), < 1 % Px (?) 7. Matrix: very fine grained 8. Secondary Minerals: dendritic Mn in some areas 9. Encrustations: thin Mn crust (< 3 mm) 10. Comment: bloc G; probably best sample for GC is 3-B which was not cut on board because of its small size	x	x	2 (Gm)					
SO233-DR-87-4	1. Rock Type: volcanic, moderately altered 2. Size: 9x10x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: reddish - brown 5. Texture / Vesicularity: dense 6. Phenocrysts: 8 % Fsp microphencrysts (< 3 mm) 7. Matrix: fine grained 8. Secondary Minerals: some pervasive Mn, Gm minerals reddish and greenishly altered 9. Encrustations: thin Mn crust (< 1 mm)	x	x	3 (Fsp)					
SO233-DR-87-5	1. Rock Type: volcanic, heavily altered 2. Size: 10x10x7 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greenish 5. Texture / Vesicularity: dense 6. Phenocrysts: 10 % Fsp (< 5 mm), well preserved 7. Matrix: fine grained, Fsp in matrix is altered 8. Secondary Minerals: Mn migrating along veins 9. Encrustations: thin Mn cover (< 1 mm) 10. Comment: Fsp phenocrysts suitable for age dating	x	x	2 (Fsp)					
SO233-DR-87-6	1. Rock Type: volcanic, very altered 2. Size: 11x7x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: greyish - green 10. Comment: similar to DR87-5; Fsp phenocrysts suitable for age dating	x	x	2 (Fsp)					
SO233-DR-87-7	1. Rock Type: volcanic, highly altered 2. Size: 8x9x6 cm 3. Shape / Angularity: rounded 4. Color of cut surface: red 5. Texture / Vesicularity: 5 % vesicles and veins 6. Phenocrysts: 10 % Fsp (< 3 mm), well preserved 7. Matrix: very fine grained, completely reddishly altered 8. Secondary Minerals: Mn abundant along veins and in voids, some clay 9. Encrustations: thin Mn Cover (< 1 mm) 10. Comment: Fsp phenocrysts suitable for age dating	x	x	2 (Fsp)					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-87-8	1. Rock Type: volcanic rock, highly altered 2. Size: 12x12x9 cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: reddish - brown 5. Texture / Vesicularity: dense, porphyritic 6. Phenocrysts: 20 % Fsp (< 3 mm), moderately preserved, Px ? 7. Matrix: fine grained 8. Secondary Minerals: pervasive Mn alteration, often replacing phenocrysts 9. Encrustations: thin Mn cover (< 1 mm) 10. Comment: Fsp partly replaced by Mn (probably not suitable for mineral separation)	x	x						
SO233-DR-87-9	1. Rock Type: volcanic rock, highly altered 2. Size: 11x8x6 cm 10. Comment: similar to DR87-8 but even more altered	x							
SO233-DR-87-10	1. Rock Type: volcanic rock 2. Size: 11x9x11 cm 3. Shape / Angularity: subangular 10. Comment: similar to DR87-8 but slightly more altered	x							
SO233-DR-87-11	1. Rock Type: volcanic rock, 2. Size: 12x10x7 cm 3. Shape / Angularity: subangular 10. Comment: similar to DR87-8 but more altered	x							
SO233-DR-87-12	1. Rock Type: volcanic, completely altered 2. Size: 7x7x7 cm 3. Shape / Angularity: subangular 10. Comment: similar to DR87-8 but much more altered	x							
SO233-DR-87-13	1. Rock Type: volcanic, highly altered 2. Size: 11x11x5 cm 3. Shape / Angularity: round 4. Color of cut surface: reddish - brown 5. Texture / Vesicularity: dense 6. Phenocrysts: 5 % Fsp (< 5 mm), moderately altered 7. Matrix: fine grained 8. Secondary Minerals: pervasive Mn alteration 9. Encrustations: Mn crust (5 mm)	x							

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-87-14	1. Rock Type: volcanic breccia (with well preserved clasts) 2. Size: 8x8x8 cm 3. Shape / Angularity: rounded breccia containing angular clasts 4. Color of cut surface: grey and reddish - brown clasts 5. Texture / Vesicularity: dense clasts 6. Phenocrysts: aphyric clasts 7. Matrix: fine grained 8. Secondary Minerals: no secondary minerals 9. Encrustations: almost no Mn crust 10. Comment: the two biggest clasts could be separated and used for GC !		?	?					
SO233-DR-87-15-S	1. Rock Type: sediment 2. Size: 21x13x10 cm 3. Shape / Angularity: subangular 4. Color of surface: yellow					x			
SO233-DR-87-16-Mn	1. Rock Type: Mn crust 2. Size: 12x10x5 cm 3. Shape / Angularity: subangular 4. Color of surface: black								
SO233-DR-87-3-X	1. Rock Type: archive samples taken from DR87-3								

SO233-TV-MUC88

Description of Location and Structure: Abyssal plain southeast of the large guyot on the southern margin of the northern Walvis Ridge.

TV-MUC on bottom	UTC 17/06/14 05:52hrs, lat 20°59.29'S, long 9°12.59'E, depth 3856m
TV-MUC off bottom	UTC 17/06/14 05:54hrs, lat 20°59.29'S, long 9°12.59'E, depth 3854m
total volume:	7 tubes
Comments:	soft sediment and bottom water, water analyses O_2 38.8 % , pH 7.80 and salt content 3.38 %

SO233-DR89

Description of Location and Structure: Northern part of Walvis Ridge, northeastern section, northwestern margin. Upper northwestern slope of a large guyot situated on the margin of the ridge.

Dredge on bottom	UTC 17/06/14 18:49hrs, lat 19°17.25'S, long 9°57.21'E, depth 2004m
Dredge off bottom	UTC 17/06/14 20:07hrs, lat 19°17.55'S, long 9°57.41'E, depth 1619m
total volume:	10 rocks, biology
Comments:	volcanic rocks (lava flow) and breccia (volcaniclastic); four lithologies: 1. Ol + Px-phyric: DR89-1 to -4, 2. aphyric with Ol + Fsp in Gm: DR89-5 + -6, 3. aphyric with Fsp in Gm: DR89-7, 4. vesicular: DR89-8 + -9

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-89-1	1. Rock Type: volcanic, quite fresh 2. Size: 23x13x9 cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: porphyritic, < 5 % vesicles filled with Cc, some veins filled with Cc 6. Phenocrysts: ~ 10 % Ol altered to iddingsite (up to 1.5 cm), ~ 10 % black Px (up to 8 mm), quite fresh 7. Matrix: fine grained with Plg and Ol (altered to iddingsite) 8. Secondary Minerals: Cc in vesicles and veins 9. Encrustations: thin Mn crust (< 1 mm)	x	x		Px				
SO233-DR-89-2	1. Rock Type: volcanic, quite fresh 2. Size: 10x7x5 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR89-1	x	x		Px				
SO233-DR-89-3	1. Rock Type: volcanic, quite fresh 2. Size: 8x7x5 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to DR89-1 but with more veins	x			Px				
SO233-DR-89-4	1. Rock Type: volcanic, quite fresh 2. Size: 9x6x3 cm 3. Shape / Angularity: angular to subangular 4. Color of cut surface: grey 10. Comment: similar to DR89-1				Px				
SO233-DR-89-5	1. Rock Type: volcanic, quite fresh 2. Size: 17x14x6 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: aphyric, dense but with several veins filled with phyllosilicates 6. Phenocrysts: aphyric 7. Matrix: very fine grained with relatively fresh Plg and Ol altered to iddingsite 8. Secondary Minerals: phyllosilicates in veins 9. Encrustations: Mn crust (~ 1 mm) 10. Comment: groundmass might be suitable for age dating (fresh Plg)	x	x	3 (Gm)					
SO233-DR-89-6	1. Rock Type: volcanic, quite fresh 2. Size: 14x9x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: ~ 5 % vesicles, partly filled with Mn and Cc (?), aphyric 10. Comment: similar to DR89-5 but contains some vesicles	x	x	3 (Gm)					

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-89-7	1. Rock Type: volcanic with fresh and altered parts 2. Size: 17x16x12 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey and reddish parts 5. Texture / Vesicularity: 15 - 20 % vesicles mainly in reddish parts, partly filled with Cc, aphyric 6. Phenocrysts: aphyric 7. Matrix: very fine grained, relatively fresh Plg 8. Secondary Minerals: Cc 9. Encrustations: Mn crust (< 2 mm) 10. Comment: rock consists of quite fresh parts but also altered and vesicular parts, therefore no GC block; fresh groundmass maybe suitable for age dating ?	x		3 (Gm)					
SO233-DR-89-8	1. Rock Type: volcanic, quite fresh 2. Size: 14x11x8 cm 3. Shape / Angularity: subangular to subrounded 4. Color of cut surface: dark grey 5. Texture / Vesicularity: 60 % vesicles, partly filled with Cc 6. Phenocrysts: aphyric 7. Matrix: fine grained 8. Secondary Minerals: Cc in vesicles, some reddish oxidation 9. Encrustations: thin Mn coating 10. Comment: fresh lava surfaces !	x	x						
SO233-DR-89-9	1. Rock Type: volcanic, quite fresh 2. Size: 12x10x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: dark grey 10. Comment: similar to DR89-8	x	x						
SO233-DR-89-10	1. Rock Type: breccia consisting of angular clasts (pyroclastic ?) 2. Size: 15x10x5 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown with light - grey clasts 5. Texture / Vesicularity: clasts show dense texture 6. Phenocrysts: aphyric 7. Matrix: fine grained matrix altered to light - grey clay minerals (?) but little Fsp show reflective surfaces 8. Secondary Minerals: Mn coating surrounds all clasts, clay minerals 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: unclear if Fsp can be used for age dating after separation			?					
SO233-DR-89-11	1. Rock Type: breccia consisting of angular clasts (pyroclastic ?) 2. Size: 12x11x6 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: brown with light - grey clasts 10. Comment: similar to DR89-10								

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-89-12	1. Rock Type: breccia containing small clasts (pyroclastic ?) 2. Size: 9x7x3 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: yellowish and brown 10. Comment: similar to DR89-10 but with much smaller clasts								

SO233-DR90

Description of Location and Structure: Northern part of Walvis Ridge, northeastern section, northwestern margin. Small "noose" at upper slope of a seamount off the northeastern termination of the margin at the base of the continental slope.

Dredge on bottom UTC 18/06/14 09:33hrs, lat 18°25.84'S, long 10°52.99'E, depth 2539m

Dredge off bottom UTC 18/06/14 10:38hrs, lat 18°25.95'S, long 10°53.31'E, depth 1619m

total volume: few rocks

Comments: volcanic

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-90-1	1. Rock Type: volcanic, quite fresh 2. Size: 23x12x13 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: ~ 10 % vesicularity, porphyritic (largly open and very small) 6. Phenocrysts: ~ 13 % altered Ol (1 - 3 mm) 7. Matrix: very fine grained, Plg 8. Secondary Minerals: Cc in cracks, Mn? in vesicles 9. Encrustations: Mn crust (1 - 2 mm) 10. Comment: needs careful TS examination, but matrix could be suitable for age dating	x	x	2-3					
SO233-DR-90-2	1. Rock Type: volcanic, quite fresh 2. Size: 14x10x9 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 10. Comment: similar to DR90-1 but no Mn-crust	x	x	2-3					
SO233-DR-90-3	1. Rock Type: volcanic 2. Size: 16x16x15 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR90-1, but ~ 5 % altered Ol (1 - 5 mm), Cpx ? phenocrysts, many cracks and outer rim comprising clasts (1 - 15 mm)	x	x						
SO233-DR-90-4	1. Rock Type: volcanic, quite fresh 2. Size: 17x14x9 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR90-1, but ~ 7 % altered Ol (1 - 3 mm)	x	x						

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-90-5	1. Rock Type: volcanic, quite fresh 2. Size: 13x10x6 cm 3. Shape / Angularity: subrounded 4. Color of cut surface: grey 10. Comment: similar to DR90-1, but ~ 4 % Ol (1 - 2 mm) and Mn crust < 0.5 mm	x	x						
SO233-DR-90-6	1. Rock Type: volcanic, relatively fresh 2. Size: 19x19x10 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: ~ 20 % vesicularity (mostly filled, very small), porphyritic 6. Phenocrysts: ~ 7 % altered Ol (< 5 mm), Cpx ?, Plg ? 7. Matrix: fine grained, Plg 8. Secondary Minerals: Cc and chalcedone? in cracks, Mn ? 9. Encrustations: Mn coating on rock suurface 10. Comment: many cracks, needs careful TS examination, but matrix could be suitable for age dating	x	x	3?					
SO233-DR-90-7	1. Rock Type: volcanic, moderately to highly altered 2. Size: 12x12x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 5. Texture / Vesicularity: ~ 30 % vesicularity(filled with Mn), porphyritic 6. Phenocrysts: ~ 17 % altered Ol (1 - 2 mm), Cpx ? 7. Matrix: fine grained, Plg 8. Secondary Minerals: Cc in cracks 9. Encrustations: Mn crust (< 2 mm) 10. Comment: edge is highly altered	x							
SO233-DR-90-8	1. Rock Type: volcanic, relatively fresh 2. Size: 12x10x9 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 5. Texture / Vesicularity: ~ 30 % vesicularity (most filled with Cc) 6. Phenocrysts: ~ 1 % altered Ol (< 1 mm) 7. Matrix: fine grained, Plg 8. Secondary Minerals: Cc in cracks 9. Encrustations: Mn crust (< 2 mm)	x							
SO233-DR-90-9	1. Rock Type: volcanic, moderately altered 2. Size: 9x7x6 cm 3. Shape / Angularity: subangular 4. Color of cut surface: brownish - grey 10. Comment: similar to DR90-8, but ~ 1 % altered Ol (< 2 mm) , ~ 25 % vesicularity (Cc or Mn?)	x							
SO233-DR-90-10	1. Rock Type: volcanic, moderately fresh 2. Size: 12x10x8 cm 3. Shape / Angularity: subangular 4. Color of cut surface: grey 10. Comment: similar to DR90-9, but ~ 12 % altered Ol (< 4 mm), Cpx ? as phenocrysts	x	x						

Appendix II: SO-233 Rock Description

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GL/MIN	SED	REF	NOTES	PICTURE
SO233-DR-11	1. Rock Type: volcanic, quite fresh 2. Size: 12x10x7 cm 3. Shape / Angularity: angular 4. Color of cut surface: grey 5. Texture / Vesicularity: 10. Comment: similar to DR90-1	x	x						
SO233-DR-12-X to -15-X	1. Rock Type: taken as archive samples similar to DR90-1, also quite fresh, but smaller (< 10 cm)								

SO233-TV-MUC91	
Description of Location and Structure: Namibian shelf northeast of the eastern termination of Walvis Ridge.	
TV-MUC on bottom	UTC 18/06/14 16:02hrs, lat 18°18.04'S, long 11°25.78'E, depth 421m
TV-MUC off bottom	UTC 18/06/14 16:04hrs, lat 18°18.04'S, long 11°25.78'E, depth 421m
total volume:	7 tubes
Comments:	dark greenish soft sediment and bottom w, water analyses O_2 13.7 % , pH 7.67 and salt content 3.39 %

SO208 Biological Samples 15.5.2014 - 21.06.2014

Abbreviations: n = number of collected specimens, FIX = fixation, F = Formalin, EtOH = 100% pure Ethanol, Glu = 2.5% Glutaraldehyde/PB-buffered, RNA=RNALater, PFA=paraformaldehyde. gDr = geological dredge, TVG = TV grab, MUC = TV-multicorer, PD = Petri dish, TOC = total organic carbon, TC=total carbon
The numbers 2, 5, 50, 100, 200, 500 and 1000 refer to the size of the vials in ml, WP= Whirl Pack, OT=Orange Tube, LC=Large Cryotube
Fixation of meiofauna from sediment traps as 1 vol sediment : 1 vol 6% formalin

SO233 - MUC1: East of first dredging station, Southern Walvis Ridge, East side
TV-MUC on bottom UTC 18/05/14 14:32hrs, lat 32°50.00'S, long 3°0.00'E, depth 4879m
TV-MUC off bottom UTC 18/05/14 14:34hrs, lat 32°50.00'S, long 3°0.00'E, depth 4879m
total volume: 6 tubes with sediment, 1 empty
Comments: muc went too deep into the sediment, two tubes probably not with sediment surface, Water analysis O2 56 % and salt content 4.7 % (faughlty refractometer)
MUC, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	11							x	1	F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Porifera	1	x								F	

SO233 - CTD2: No protocol, since winch had problems for about 1 hr and crew started CTD after succesful repair
Dredge on bottom:
Dredge off bottom:
total volume: 24 tubes of water
Comments: 3 tubes per depth filtered over 40µm mesh, fixed in formalin
CTD, water

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Plankton	unsorted, 2500 m						x				F	jars filled with 20 ml max.
	unsorted, 2000 m						x				F	
	unsorted, 1500 m						x				F	
	unsorted, 1200 m						x				F	
	unsorted, 1000 m						x				F	
	unsorted, 700 m						x				F	
	unsorted, 500 m						x				F	
	unsorted, 200 m						x				F	

SO233 - DR3: Southern part of Walvis Ridge. Guyot like Seamount on SE-margin of the ridge, upper part of western flank
Dredge on bottom UTC 19/05/14 01:18hrs lat 32°50.95'S long 2°29.72'E depth 2165m
Dredge off bottom UTC 19/05/14 02:45hrs lat 32°51.27'S long 2°30.21'E depth 1578m
total volume: 1/4 full
Comments: Few angular lavas, volcanoclastics sediments, Mn-crust
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted								1		F	from sediment traps
												500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Polychaeta	2	x								EtOH	
	Cnidaria	1	x								EtOH	solitairy Hexacorallia, Caryophyllia?
	Ophiuroida	1	x								EtOH	piece of arm with long spines
	Crinoida	1	x								EtOH	very small, bright yellow
	Porifera	1	x								F	stick-like
	Bivalvia	>5	x								F	taxodont, Nuculidae?

SO233 - DR4: Southern Walvis Ridge. Western edge of the eastern "finger" in area 1. Lower slope.
Dredge on bottom UTC 19/05/14 11:35hrs lat 32°55.37'S long 1°28.87'E depth 3040m
Dredge off bottom UTC 19/05/14 13:04hrs lat 32°55.33'S long 1°29.03'E depth 2565m
total volume: One piece of Mn-encrusted volcanic breccia
Comments: Suitable for GC but needs picking
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR5: Same structure as DR4 but 6sm further north where slope is steeper
Dredge on bottom UTC 19/05/14 15:40hrs lat 32°49.28'S long 1°28.22'E depth 2900m
Dredge off bottom UTC 19/05/14 18:30hrs lat 32°49.24'S long 1°28.66'E depth 2496m
total volume: two
Comments: separation of two clasts (1-b & 1-c) from the epiclastic breccia (1-a)
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR6: Southern Walvis Ridge, middle part. Southern flank of the eastern "finger" of a seamount. Upper part of the slope.

Dredge on bottom UTC 20/05/14 05:51hrs lat 33°16.17'S long 0°18.74'W depth 2449m
Dredge off bottom UTC 20/05/14 07:10hrs lat 33°15.78'S long 0°18.95'W depth 2025m
total volume: one small piece of Mn-encrusted breccia
Comments: separation of two clasts (1a & 1b) from the breccia

gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR7: Southern Walvis Ridge, middle post / finger. Slightly east of DR6 and slightly deeper.

Dredge on bottom UTC 20/05/14 09:15hrs lat 33°16.44'S long 0°16.50'W depth 2643m
Dredge off bottom UTC 20/05/14 10:30hrs lat 33°16.02'S long 0°16.65'W depth 2310m
total volume: 10 sedimentary rocks
Comments: carbonate with plenty sand-size volcaniclastic fragments or mineral fragments?

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	hexactinellid
	Porifera	1	x								EtOH	hexactinellid

SO233 - TVG8: Southern Walvis Ridge. Top plateau of DR6 and 7 seamount. Small mount approximately in the center of the plateau

TVG on bottom UTC 20/05/14 14:00hrs lat 33°15.49'S long 0°29.19'W depth 1088m
TVG off bottom UTC 20/05/14 15:52hrs lat 33°15.35'S long 0°29.38'W depth 1211m
total volume: full
Comments: sandy sediment consisting of forams

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	4							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Pteropoda	>100							x		dry	dead shells from sediment
	Brachiopoda	>50								x	dry	*Stenosarina crosnieri* , dead shells, partly broken
	Brachiopoda	3								x	dry	?*Hispanirhynchia cornea* , 1 vv, 1 total
	Bivalvia	>20								x	dry	Limopsis sp., dead shells
	Bivalvia	3								x	dry	?Corbula sp.
	Gastropoda	5								x	dry	*Janthina janthina* , dead shells, small specimens
	Gastropoda	3								x	dry	
	Cnidaria	>5								x	dry	different solitary species
	Cnidaria	5								x	dry	styasterids on brachiopod shells
	Porifera	3								x	dry	pieces of hexactinellid
	Echinodermata	1								x	dry	small piece of formerly large echinoid test

SO233 - DR9: Southern Walvis Ridge, middle part. Same structure as DR7, but 40nm SW

Dredge on bottom UTC 20/05/14 22:24hrs lat 33°40.43'S long 0°45.03'W depth 2907m
Dredge off bottom UTC 20/05/14 23:34hrs lat 33°40.06'S long 0°45.18'W depth 2501m
total volume: 12 rocks, whereby 2 clastic sediments and the rest Mn crust
Comments:

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Polychaeta	1	x								EtOH	maldanid?

SO233 - DR10: Southern Walvis Ridge, middle part. Same structure as DR9, but 12sm W

Dredge on bottom UTC 21/05/14 04:18hrs lat 33°40.29'S long 0°57.27'W depth 2981m
Dredge off bottom UTC 21/05/14 05:20hrs lat 33°39.99'S long 0°57.47'W depth 2764m
total volume: 3 rocks
Comments:

gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR11: Southern Walvis Ridge, northern part of the eastern "finger". NW-SE trending large ridge-like seamount. Dredge track along NW-slope

Dredge on bottom UTC 22/05/14 14:45hrs lat 30°41.12'S long 2°11.95'E depth 3000m
Dredge off bottom UTC 22/05/14 16:00hrs lat 30°40.81'S long 2°11.96'E depth 2679m
total volume: few sedimentary rocks
Comments: soft silty sediment, 6 pieces up to 50 cm, partly with Mn crust on surface

gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR12: Southern Walvis Ridge, eastern part. Upper part of plateau edge.
Dredge on bottom UTC 23/05/14 04:24hrs lat 29°36.03'S long 3°04.95'E depth 2400m
Dredge off bottom UTC 23/05/14 05:33hrs lat 29°35.68'S long 3°04.81'E depth 2005m
total volume: few rocks and 1 large bloc
Comments: Coral limestone with thin Mn crust
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	Asbestopluma?
	Porifera	>5	x								EtOH	
	Porifera	1	x								EtOH	Hexactinellid
	Porifera	1	x								EtOH	
	Porifera	1	x								EtOH	
	Porifera	1	x								EtOH	pinkish colour, with central "stalk"
	Cinidaria	1								x	dry	dead coral

SO233 - DR13: Southern Walvis Ridge, eastern part. Same structure as DR12, but 2sm further east and 400m below.
Dredge on bottom UTC 23/05/14 07:40hrs lat 29°36.30'S long 3°06.29'E depth 2552m
Dredge off bottom UTC 23/05/14 08:45hrs lat 29°36.08'S long 3°6.10'E depth 2300m
total volume: few rocks
Comments: Mn crusts
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Polychaeta	3	x								EtOH	serpulids with serrated tubes
	Bryozoa	1	x								EtOH	ctenostome
	Ophiuroidea	1	x								EtOH	juvenile?

SO233 - TV-MUC14: Southern Walvis Ridge, Western part of branching area Gough / Tristan
TV-MUC start UTC 24/05/14 14:40hrs, lat 28°55.00'S, long 2°39.71'E, depth 3083m
TV-MUC ON DECK UTC 24/05/14 15:58hrs, lat 28°54.90'S, long 2°39.50'E, depth 3083m
total volume: empty
Comments: Tubes partly closed due to swell-related uplift of the MUC, cancelled at ~ 2000m, empty on deck
MUC

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna												

SO233 - DR15: Southern Walvis Ridge, eastern part. Valley directed to south-east, eastern flank.
Dredge on bottom UTC 24/05/14 23:05hrs lat 28°35.50'S long 3°08.36'E depth 3936m
Dredge off bottom UTC 25/05/14 00:21hrs lat 28°35.81'S long 3°8.00'E depth 3661m
total volume: one big bloc and one small rock
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR 16: Narrow part of Walvis Ridge, slightly north of the DSDP sites. Very steep, narrow canyon striking SE, dredge track runs up its western wall
Dredge on bottom UTC 25/05/14 09:46 hrs lat 28°25.381'S long 3°40.66'E depth 3630m
Dredge off bottom UTC 25/05/14 11:03 hrs lat 28°25.574'S long 3°40.363'E depth 3186m
total volume: 1 rock, 2 coral fragments
Comments: potential px-cumulate?
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria, Octocorallia	2								x	dry	Gorgonaria, dead branched stems

SO233 - TV-MUC 17: Slope SE of DR16, E side of Southern Walvis Ridge
TV-MUC on bottom UTC 25/05/14 15:05hrs, lat 28°29.50'S, long 3°49.00'E, depth 4850m
TV-MUC off bottom UTC 25/05/14 15:30hrs, lat 28°29.60'S, long 3°49.10'E, depth 4862m
total volume: 6 tubes with sediment, 1 empty
Comments: springs too strong, needs weaker ones, too much tension on lids of partly closed tubes, Water analysis O2 48.8 %, salt 4 % and temperature 6.7°
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	11							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)

SO233 - TVG 18: Narrow part of Walvis Ridge. Not DSDP sites. Plateau of large guyot, eastern plaeau edge.
TVG on bottom UTC 25/05/14 19:32hrs lat 28°26.90'S long 3°37.90'E depth 1626m
TVG off bottom UTC 25/05/14 20:25hrs lat 28°26.72'S long 3°37.74'W depth 1624m
total volume: full
Comments: first try with open shovel, second try successful, sandy sediment consisting of forams
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	4							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Polychaeta	1	x								F	
	Polychaeta	2	x								F	Spionidae
	Gastropoda	>5	x								F	Hydrobiidae?
	Sipuncula	1	x								F	completely transparent

SO233 - DR 19: Narrow part of souther Walvis Ridge. Large guyot, eastern slope.
Dredge on bottom UTC 25/05/14 23:04hrs, lat 28°26.40'S, long 3°39.37'E, depth 2450m
Dredge off bottom UTC 26/05/14 00:31hrs, lat 28°25.95'S, long 3°38.86'E, depth 2106m
total volume: one rock
Comments: epiclastic sediment was split to two clasts (1-A and 1-B) and the matrix (1-C)
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR 20: Southern Walvis Ridge, eastern part. 13 km north of DR19, eastern slope of guyot.
Dredge on bottom UTC 26/05/14 03:56hrs, lat 28°18.58'S, long 3°39.23'E, depth 2717m
Dredge off bottom UTC 26/05/14 06:41hrs, lat 28°18.67'S, long 3°39.28'E, depth 2792m
total volume: 3 rocks
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps

SO233 - DR 21: Central Walvis Ridge. N-S elongated ridge structure. Dredge haul is up the SE slope to the NW
Dredge on bottom UTC 26/05/14 15:18hrs, lat 27°57.325'S, long 3°7.697'E, depth 2694m
Dredge off bottom UTC 26/05/14 16:39hrs, lat 27°57.007'S, long 3°7.525'E, depth 2406m
total volume: 3 rocks
Comments: one clastic sediment, two carbonate crusts
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria/Porifera	1						x			F	piece of gorgonian coral with sponge-like tissue between branches
	Porifera	1			x						EtOH	piece of sponge-like tissue, disintegrated upon contact with EtOH

SO233 - MUC 22: Southern Walvis Ridge, central axis, plain NE of DR21
TV-MUC on bottom UTC 26/05/14 20:09hrs, lat 27°53.20'S, long 3°13.80'E, depth 3179m
TV-MUC off bottom UTC 26/05/14 20:11hrs, lat 27°53.20'S, long 3°13.80'E, depth 3179m
total volume: empty
Comments: all tubes empty when MUC back on deck, tubes only 10-15 cm into the sediment, washed out on the way up
MUC

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna												

SO233 - DR 23: Southern - Central Walvis Ridge, central axis. N - S, elongated structure 3sm NNE from DR21, lower part of the slope
Dredge on bottom UTC 26/05/14 23:07hrs, lat 27°54.50'S, long 3°09.32'E, depth 2863m
Dredge off bottom UTC 27/05/14 00:30hrs, lat 27°54.36'S, long 3°8.84'E, depth 2478m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 24: Southern-Central Walvis Ridge, 1sm NE of DR21
Dredge on bottom UTC 27/05/14 2:48hrs, lat 27°56.85'S, long 3°08.81'E, depth 2928m
Dredge off bottom UTC 27/05/14 4:01hrs, lat 27°56.45'S, long 3°08.47'E, depth 2542m
total volume: 1 huge bloc
Comments: Old coral reef with volcanic clasts
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria	2	x								EtOH	Coronata
	Porifera	1	x								EtOH	hexactinellid
	Bryozoa	2	x								EtOH	ctenostome
	Tunicata	1	x								EtOH	surface encrusted with forams
	?	1	x								EtOH	calcified, foot of coral?

SO233 - DR 25: Central Walvis Ridge. N-S elongated structure north of where we dredged DR23, northern edge.
Dredge on bottom UTC 27/05/14 10:38hrs, lat 27°34.60'S, long 3°06.06'E, depth 2602m
Dredge off bottom UTC 27/05/14 11:55hrs, lat 27°34.59'S, long 3°05.60'E, depth 2401m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 26: Cenral Walvis Ridge, extension of ridge where DR25 was taken
Dredge on bottom UTC 27/05/14 10:38hrs, lat 27°20.35'S, long 3°0.76'E, depth 3200m
Dredge off bottom UTC 27/05/14 17:29hrs, lat 27°20.48'S, long 3°0.42'E, depth 2776m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 27: Central Walvis Ridge, northernmost part of the elongated structure of DR22-26
Dredge on bottom UTC 27/05/14 21:18hrs, lat 27°15.45'S, long 2°57.74'E, depth 3364m
Dredge off bottom UTC 27/05/14 22:55hrs, lat 27°15.36'S, long 2°57.64'E, depth 3300m
total volume: 2 rocks
Comments: bridge took over at 3360m wire lengths; Breccia
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 28: Walvis Ridge, middle part, western side. Western side of the seamount.
Dredge on bottom UTC 28/05/14 07:50hrs, lat 26°18.37'S, long 3°02.66'E, depth 4100m
Dredge off bottom UTC 28/05/14 09:15hrs, lat 26°18.37'S, long 3°02.??'E, depth 3900m
total volume: 4 rocks
Comments: bridge took over at 4230m wire lengths; volcanic rocks (3 lavas and 1 tuff)
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 29: Walvis Ridge, middle part. Slope slightly to the NE and slightly higher than DR28.
Dredge on bottom UTC 28/05/14 13:02hrs, lat 26°16.45'S, long 3°1.86'E, depth 3424m
Dredge off bottom UTC 28/05/14 14:21hrs, lat 26°16.82'S, long 3°01.59'E, depth 3133m
total volume: half full
Comments: volcanic rocks, lava, eoiclastic sediments, one sediment; five different lithologies:
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	
	Bryozoa	1	x								EtOH	several pieces, with long calcified 'rootlets'

SO233 - TV-MUC30: Walvis Ridge abyssal plain, middle part, west side. East of DR29
TV-MUC on bottom UTC 28/05/14 18:18hrs, lat 26°13.80'S, long 3°5.80'E, depth 4722m
TV-MUC off bottom UTC 28/05/14 18:19hrs, lat 26°13.80'S, long 3°5.80'E, depth 4721m
total volume: 1 tube with sediment, 6 empty
Comments: washed out on the way up
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	500ml sediment per Kautex jar

SO233 - DR 31: Souther-Central Walvis Ridge. Northernmost part of the elonated structure of DR22-26. 2sm NE and deeper as DR28.
Dredge on bottom UTC 29/05/14 00:18hrs, lat 26°17.13'S, long 3°3.67'E, depth 4687m
Dredge off bottom UTC 29/05/14 01:40hrs, lat 26°17.25'S, long 3°3.12'E, depth 4143m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 32: Central Walvis Ridge, northern appendix
Dredge on bottom UTC 29/05/14 09:14hrs, lat 26°28.85'S, long 3°09.23'E, depth 4013m
Dredge off bottom UTC 29/05/14 11:13hrs, lat 26°28.88'S, long 3°09.12'E, depth 3500m
total volume: 2 rocks (and one small piece in sediment catcher)
Comments: volcanic rocks
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 33: Central Walvis Ridge, nortehrn appendix (eastern ridge). Steep , deep slope of main Walvis Ridge.
Dredge on bottom UTC 29/05/14 18:26hrs, lat 26°16.38'S, long 3°22.97'E, depth 3963m
Dredge off bottom UTC 29/05/14 19:33hrs, lat 26°16.63'S, long 3°22.77'E, depth 3666m
total volume: empty
Comments:
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Bivalvia	1			x						F	taxodont, Arcidae

SO233 - DR 34: Central Walvis Ridge, northern appendix (eastern ridge). Same guyot as DR33, 4sm E
Dredge on bottom UTC 29/05/14 23:09hrs, lat 26°17.32'S, long 3°28.20'E, depth 4217m
Dredge off bottom UTC 30/05/14 00:23hrs, lat 26°17.44'S, long 3°27.66'E, depth 3817m
total volume: one bloc
Comments: volcaniclastic sediment with volcanic clasts up to to 9 cm; clasts were separated
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Bivalvia	1	x								F	taxodont, *Arca* ?
	Gastropoda	1	x								F	

SO233 - DR 35: Central Walvis Ridge, northern appendix (western side). Same seamount as DR32-34 but western side and steeper slope.
Dredge on bottom UTC 30/05/14 06:29hrs, lat 26°13.23'S, long 3°18.76'E, depth 4063m
Dredge off bottom UTC 30/05/14 07:52hrs, lat 26°13.64'S, long 3°18.78'E, depth 3700m
total volume: more than half full
Comments: fresh volcanic rocks with glass rims
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria	1	x								EtOH	Coronata
	Isopoda	1	x								F	
	Amphipoda	1	x								EtOH	from ship's hull?

SO233 - TV-MUC 36: Walvis Ridge, central part

TV-MUC on bottom UTC 30/05/14 16:59hrs, lat 26°28.84'S, long 4°28.17'E, depth 2531m
TV-MUC off bottom UTC 30/05/14 17:04hrs, lat 26°28.17'S, long 4°28.17'E, depth 2530m
total volume: 2 tubes with ~10 cm of sediment, 1 with surface and supernatant water, 4 empty
Comments: salinity 3,39 %, O_2 46 % and pH 7.27

TV-MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	3							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna												

SO233 - DR 37: Walvis Ridge, Central Part. Eastern Ridge and slope of the central ridge structure.

Dredge on bottom UTC 31/05/14 01:17hrs, lat 26°50.64'S, long 4°55.84'E, depth 3159m
Dredge off bottom UTC 31/05/14 02:33hrs, lat 26°50.25'S, long 4°55.67'E, depth 2720m
total volume: one volcaniclastic sediment
Comments: two clast were seperated

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Bivalvia	1	x								F	taxodont, Nuculidae?
	?Echinodermata	1	x								F	tooth of echinoid?

SO233 - DR 38: Central High of Walvis Ridge, southwestern "fingers". Sope of southern "finger".

Dredge on bottom UTC 31/05/14 08:44hrs, lat 26°40.95'S, long 5°19.97'E, depth 2600m
Dredge off bottom UTC 31/05/14 02:33hrs, lat 26°40.61'S, long 5°19.94'E, depth 2170m
total volume: sedimentary rocks
Comments: unconsolidated sediment and two hard sediments

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria	1	x								EtOH	Coronata
	Tunicata	1						x			F	*Pyrosoma* sp.
	Tunicata	1				x					EtOH	piece of the *Pyrosoma* specimen above

SO233 - DR 39: Central Walvis Ridge, southern, southwestern striking finger. Northern slope of southern finger.

Dredge on bottom UTC 31/05/14 14:47hrs, lat 26°30.27'S, long 5°11.08'E, depth 2086m
Dredge off bottom UTC 31/05/14 15:58hrs, lat 26°30.53'S, long 5°10.79'E, depth 1830m
total volume: half full
Comments: volcanics, volcaniclastic sediments and carbonates

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Brachiopoda	1	x								EtOH	*Eucalathis*
	Brachiopoda	1	x								EtOH	*Novocrania*
	Bryozoa	1	x								EtOH	
	Bryozoa	1	x								EtOH	
	Bryozoa	>10	x								EtOH	mainly Ctenostomata
	Isopoda	1	x								EtOH	
	Sipuncula	3	x								EtOH	
	Bivalvia	5	x								F	taxodont, Nuculidae?
	Molusca	3	x								F	2 scaphopods, 1 pelagic gastropod
	Polychaeta	1	x								EtOH	Aphroditidae
	Polychaeta	1	x								EtOH	
	Polychaeta	2			x						EtOH	Eunicidae
	Cnidaria	1	x								EtOH	Coronata
	Cnidaria	10	x								EtOH	Coronata
	Cnidaria	1			x						dry	dead Hexacorallia: *Vaughanella*?
	Porifera	>5	x								EtOH	
	Porifera	3	x								EtOH	
	Porifera	>10	x								EtOH	
	Porifera	1	x								EtOH	
	Porifera	2	x								EtOH	could be tunicates as well?
	Porifera	>10		x							EtOH	
	Porifera	>5	x								EtOH	
	Porifera	2	x								EtOH	
	?	1	x								EtOH	
	Amphipoda	1	x								EtOH	
	Foraminifera	1			x						dry	~ 1 cm diameter, with radial striation
	?	1			x						dry	triangular, curved, calcified, with growth lines

SO233 - DR 40: Central Walvis Ridge, N-S elongated seamount south of the two southwestern striking "fingers". Northwestern slope of seamount.
Dredge on bottom UTC 01/06/14 09:32hrs, lat 26°49.14'S, long 5°36.55'E, depth 3577m
Dredge off bottom UTC 01/06/14 10:35hrs, lat 26°49.39'S, long 5°36.39'E, depth 3260m
total volume: few rocks
Comments: several large sedimentary boulders, one big volcanic rock
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	hexactinellid
	Porifera	2	x								EtOH	
	Cnidaria	1	x								EtOH	Coronata

SO233 - DR 41: Central Walvis Ridge, N-S elongated seamount south of the two southwestern striking "fingers". Northeastern slope of seamount.
Dredge on bottom UTC 01/06/14 13:25hrs, lat 26°49.66'S, long 5°39.64'E, depth 2930m
Dredge off bottom UTC 01/06/14 14:45hrs, lat 26°50.09'S, long 5°39.50'E, depth 2664m
total volume: few big rocks
Comments: volcanics, sedimens and Mn crust
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	
	Cnidaria	3	x								EtOH	Coronata
	Sipuncula	1	x								EtOH	
	? Egg capsule	1	x								EtOH	rose color, same as in #DR 45

SO233 - TV-MUC42: Cenral Walvis Ridge , abyssal plain south of DR38
TV-MUC on bottom UTC 01/06/14 18:44hrs, lat 26°52.20'S, long 5°26.40'E, depth 4044m
TV-MUC off bottom UTC 01/06/14 18:45hrs, lat 26°52.20'S, long 5°26.40'E, depth 4033m
total volume: 7 tubes with sediment
Comments: salinity 3.36 %, O_2 46.6 % and pH 8.0
TV-MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	13							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Cirripedia	3			x						EtOH	from ship's hull

SO233 - DR 43: Central Walvis Ridge, Eastern part. Southeastern slope of the Graben-structure
Dredge on bottom UTC 02/06/14 00:23hrs, lat 26°43.01'S, long 4°56.69'E, depth 2440m
Dredge off bottom UTC 02/06/14 01:42hrs, lat 26°43.47'S, long 4°56.63'E, depth 2001m
total volume: 10 rocks
Comments: volcanic
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	
	Porifera	5	x								EtOH	
	Bryozoa	2	x								EtOH	

SO233 - DR 44: West of central Walvis Ridge Plateau, double-summit seamount. Northern slope of southern summit
Dredge on bottom UTC 02/06/14 12:27hrs, lat 25°20.00'S, long 4°50.65'E, depth 2282m
Dredge off bottom UTC 02/06/14 13:42hrs, lat 25°21.28'S, long 4°50.74'E, depth 1921m
total volume: empty
Comments:
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Gastropoda	2	x								F	1 Atlantidae, the other ?
	Gastropoda	1	x								F	Fissurellidae, transparent with tubercles on shell
	Bivalvia	2	x								F	taxodont, Nuculidae?, one closed

SO233 - DR 45: Same location as DR44, slightly East and downslope.

Dredge on bottom UTC 02/06/14 15:43hrs, lat 25°19.43'S, long 4°53.59'E, depth 2582m
Dredge off bottom UTC 02/06/14 16:59hrs, lat 25°19.88'S, long 4°53.40'E, depth 2181m
total volume: few rocks
Comments: volcanics, volcaniclastic sediments and sediments
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	3	x								EtOH	3 specimens of the same species
	Cnidaria	3	x								EtOH	Coronata
	? Egg capsules	2	x								EtOH	one hatched, one full, rose color

SO233 - DR 46: Central Walvis Ridge, western part. Same structure as DR44 but northern slope of northern summit.

Dredge on bottom UTC 02/06/14 21:38hrs, lat 25°08.31'S, long 4°57.71'E, depth 3306m
Dredge off bottom UTC 02/06/14 23:00hrs, lat 25°08.79'S, long 4°57.79'E, depth 2895m
total volume: four rocks (one igneous)
Comments: one volcanic pebble
gDR, sedimen, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Polychaeta	1	x								EtOH	
	Bivalvia	2	x								F	Arcidae
	Scaphopoda	1	x								F	

SO233 - DR 47: Same seamount as at DR46, northern slope of seamount summit.

Dredge on bottom UTC 03/06/14 01:54hrs, lat 25°10.26'S, long 4°55.51'E, depth 2538m
Dredge off bottom UTC 03/06/14 03:08hrs, lat 25°10.71'S, long 4°55.51'E, depth 2157m
total volume: one rock
Comments: sedmentary carbonate crust with Mn crust
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	5	x								EtOH	
	Cnidaria	2	x								EtOH	Coronata
	Cnidaria	1								x	dry	dead hexacorallia
	Mollusca	1	x								dry	dead bivalve shell with forams
	Mollusca	4	x								F	1 scaphopod, 1 pteropod, 1 nuculid?, 1 gastropod
	Gastropoda	3	x								F	Atlantidae
	?Echinodermata	1	x								F	tooth of echinoid?

SO233 - DR 48: Central Walvis Ridge, Western Part. Steep Ridge structure ~20 sm to the WNW of DR47

Dredge on bottom UTC 03/06/14 08:11hrs, lat 25°04.99'S, long 4°35.35'E, depth 2965m
Dredge off bottom UTC 03/06/14 09:42hrs, lat 25°05.42'S, long 4°35.34'E, depth 2518m
total volume: < half full
Comments: volcanic, volcaniclastic rocks and sediments (carbonates)
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria	4	x								EtOH	Coronata
	Actiniaria	1	x								EtOH	
	Polychaeta	1	x								EtOH	serpulid tube
	Ophiuroidea	1	x								EtOH	a single arm
	Bivalvia	2	x								F	taxodont, Nuculidae?
	Foraminifera	1								x	dry	

SO233 - TV-MUC 49: East side of Walvis Ridge, Central part (North of DR48)

TV-MUC on bottom UTC 03/06/14 13:25hrs, lat 24°56.70'S, long 4°32.63'E, depth 4655m
TV-MUC off bottom UTC 03/06/14 13:25hrs, lat 24°56.82'S, long 4°32.65'E, depth 4647m
total volume: empty
Comments: all tubes washed out when MUC on deck
TV MUC

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna												

SO233 - DR 50: Central Walvis Ridge, Western flank. Unexpected cone-shaped seamount on western flank.
Dredge on bottom UTC 03/06/14 19:55hrs, lat 24°57.29'S, long 5°08.28'E, depth 3324m
Dredge off bottom UTC 03/06/14 21:13hrs, lat 24°57.70'S, long 5°08.39'E, depth 2896m
total volume: one rock
Comments: sedimentary rock with Mn particles
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Polychaeta	1	x								F	in three pieces
	Cirripedia	1	x								F	crushed

SO233 - DR 51: Central Walvis Ridge massive. Cliff at plateau edge.
Dredge on bottom UTC 04/06/14 06:21hrs, lat 25°10.92'S, long 5°41.05'E, depth 1540m
Dredge off bottom UTC 04/06/14 07:33hrs, lat 25°11.31'S, long 5°41.09'E, depth 1210m
total volume: few rocks
Comments: carbonates and corals
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	*Asbestopluma* ?
	Porifera	1	x								F	hexactinellid
	Nematoda	1	x								EtOH	large specimen
	Cnidaria	1			x						EtOH	Isididae, one stem with spiny polyps
	Cnidaria	>10								x	dry	dead octocoral skelet., partly *Corallium* ? 2 bags
	Cnidaria	>10								x	dry	mix of Octocorallia and Caryophyllid skeletons
	Cnidaria	5			x						EtOH	small, purple alcyonarian colonies
	Cnidaria	1								x	dry	one twig of *Enallopsammia rostrata*
	Cnidaria	2								2L	F	two branches of octocorals
	Bivalvia	7								x	dry	1 juv. *Acesta angolensis* , 6 Arcidae
	Bivalvia	1	x								EtOH	*Arca* sp.
	Bivalvia	1	x								F	taxodont, Nuculidae?
	Gastropoda	>5	x								F	4 species, 1 Atlantidae
	Bryozoa	>10			x						EtOH	branched cheilostomes, rectangular cross section
	Bryozoa	2	x								EtOH	1 ctenostome, 1 cheilostome
	Brachiopoda	2	x								F	*Eucalathis* , 1 on hexacoral, 1 with separated shell
	Brachiopoda	3								x	dry	3 pieces of *Stenosarina* with corals
	Cirripedia	1	x								EtOH	
	Ophiuroidea	3	x								EtOH	two pieces of a crushed, orange basket star
	Ophiuroidea	2	x								PFA	two arm pieces (tip and base), orange basket star
	Ophiuroidea	1	x								F	remains of the orange basket star

SO233 - DR 52: Central Walvis Ridge massiv. Same location as DR51, slightly further west.
Dredge on bottom UTC 04/06/14 09:14hrs, lat 25°12.55'S, long 5°39.36'E, depth 1587m
Dredge off bottom UTC 04/06/14 10:52hrs, lat 25°12.67'S, long 5°39.74'E, depth 1294m
total volume: few rocks
Comments: bridge took over at 10:20, carbonate sediments
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	
	Porifera	1	x								EtOH	slimy, yellowish on isidid coral
	Cnidaria	>5								x	dry	dead octocorals, probably *Corallium*
	Cnidaria	1								x	dry	caryophyliid hexacoral
	Cnidaria	1						x			F	Isididae
	Cnidaria	1			x						EtOH	Isididae, piece of the same specimen as above
	Cnidaria	1			x						EtOH	Isididae
	Cnidaria	3						x			F	Alcyonaria, pinkish polyps
	Cnidaria	3	x								EtOH	Alcyonaria, pinkish polyps, same as above
	Polychaeta	3	x								EtOH	three tubes
	Polychaeta	1	x								EtOH	
	? Egg capsule	1	x								EtOH	

SO233 - DR 53: Central Walvis Ridge plateau, southern High. NE slope of highest structure.
Dredge on bottom UTC 05/06/14 03:08hrs, lat 25°59.60'S, long 6°30.85'E, depth 2163m
Dredge off bottom UTC 05/06/14 03:56hrs, lat 25°59.40'S, long 6°30.99'E, depth 1990m
total volume: few sedimentary rocks
Comments: sediment with Mn crust
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	>5	x								EtOH	different species
	Bryozoa	2	x								EtOH	two pieces of a ctenostome colony
	Brachiopoda	1	x								EtOH	*Novocrania* , very small
	Ophiuroidea	1	x								PFA	half of the animal
	Ophiuroidea	1	x								EtOH	other half of the animal

SO233 - DR 54: Central Walvis Ridge, south-eastern part.
Dredge on bottom UTC 05/06/14 15:58hrs, lat 26°32.08'S, long 6°13.24'E, depth 2877m
Dredge off bottom UTC 05/06/14 17:00hrs, lat 26°32.28'S, long 6°13.60'E, depth 2446m
total volume: few corals
Comments:
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	>10	x								EtOH	small, needle like spicules
	Cnidaria	3	x								EtOH	small, reddish alcyonacean polyps with stolons
	Cnidaria	1	x								EtOH	very small octocoral stem, with one polyp
	Cnidaria	>5								x	dry	dead octocorals, two species, one is ?*Corallium*
	Amphipoda	1	x								EtOH	
	Cirripedia	>10	x								EtOH	on dead octocoral stem
	Bryozoa	2	x								EtOH	2 pieces of the same branched colony

SO233 - DR 55: Central Walvis Ridge, southern edifice. Cone SW of highest summit, western slope.
Dredge on bottom UTC 05/06/14 20:47hrs, lat 26°29.54'S, long 6°11.62'E, depth 2459m
Dredge off bottom UTC 05/06/14 21:58hrs, lat 26°29.74'S, long 6°11.98'E, depth 2169m
total volume: carbonate crusts
Comments:
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1	x								EtOH	small, globular hexactinellid
	Porifera	1	x								EtOH	could also be a tunicate?
	Cnidaria	4	x								EtOH	Coronata
	Polychaeta?	2	x								EtOH	2 whitish worms in a chitinous tube
	Cirripedia	1	x								EtOH	furry appearance, overgrown with sponge?
	Bivalvia	1	x								EtOH	single dead shell, with two teeth, very small

SO233 - DR 56: Central Walvis Ridge edifice, Northwest corner of plateau
Dredge on bottom UTC 06/06/14 06:51hrs, lat 26°19.93'S, long 6°07.12'E, depth 1254m
Dredge off bottom UTC 06/06/14 07:30hrs, lat 26°20.04'S, long 6°07.12'E, depth 1063m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - TVG 57: Central Walvis Ridge, South of Valdivia Bank.

TVG on bottom UTC 06/06/14 12:20hrs lat 26°18.14'S long 6°26.40'E depth 1517m
TVG off bottom UTC 06/06/14 14:07hrs lat 26°18.40'S long 6°26.90'W depth 1666m
total volume: full
Comments: sandy sediment consisting of forams; many corals and shells, few rocks
gDR, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Porifera	3								x	dry	2 pieces *Aphrocallistes* , 1 other
	Porifera	1								x	dry	1 stem of hexactinellid with large basis
	Porifera	2	x								EtOH	cone shaped hexactinellids
	Porifera	1	x								EtOH	yellow, stem and 2 oscula, could also be tunicate
	Cnidaria	>50								x	dry	solitairy Caryophyllidae, 2-3 species
	Cnidaria	>10								x	dry	solitairy Caryophyllidae, with long stem
	Cnidaria	>10								x	dry	anastomosing hexacorals, different species
	Cnidaria	2								x	dry	stout, solitairy Caryophyllidae, one Mn-encrusted
	Cnidaria	>10								x	dry	mixture of hexacorals and octocorals, 1 oct. Fresh
	Cnidaria	10								x	dry	large hexacorals, deep calices, solitairy?
	Cnidaria	1								x	dry	Caryophyllidae, solitairy, small, erect, juveniles attached
	Cnidaria	6								x	dry	*Stephanocyathus* sp.
	Cnidaria	3								x	dry	*Caryophyllia valdiviae*
	Cnidaria	2								x	dry	*Stephanocyathus campaniformis*
	Cnidaria	4								x	dry	*Flabellum alabastrum*
	Cnidaria	>10								x	dry	*Deltocyathus conicus*
	Cnidaria	1								x	dry	*Caryophyllia balaenacea*
	Cnidaria	8								x	dry	*Flabellum* sp.
	Cnidaria	4								x	dry	minute branched hexacorals, 2-3 species
	Scaphopoda	>10								x	dry	
	Gastropoda	>10								x	dry	*Janthina janthina*
	Gastropoda	1								x	dry	piece of fossil? Giant oyster
	Gastropoda	>10								x	dry	Muricidae?
	Gastropoda	1								x	dry	Patellidae
	Gastropoda	7								x	dry	Buccinidae
	Gastropoda	6								x	dry	large, orange, smooth, pointed shell
	Gastropoda	1								x	dry	Turridae
	Gastropoda	1								x	dry	large, globular, with concentric rings
	Gastropoda	>10								x	dry	mixture of about 7 species, small shells
	Bivalvia	>20								x	dry	single valves of *Acesta angolensis*
	Bivalvia	10								x	dry	single valves of Glossidae
	Bivalvia	1								x	dry	eroded piece of Oyster shell
	Bivalvia	6								x	dry	Oyster? related bivalves, squarish, elongated
	Brachiopoda	>50								x	dry	*Compsothyris racovitzae*
	Brachiopoda	>50								x	dry	*Stenosarina crosnieri*
	Brachiopoda	>50								x	dry	*Dyscolia* sp.
	Brachiopoda	3								x	dry	*?Gryphus* sp.
	Brachiopoda	1	x								EtOH	*Platidia* sp.
	Mammalia	1								x	dry	eroded piece of backbone
	?Echinodermata	3								x	dry	teeth of Aristotle's lantern?
	?Echinodermata	1	x								EtOH	tooth of echinoid? Much smaller than the others
	Rhodoliths	7								x	dry	one larger rodolith sawn in 2 pieces

SO233 - DR 58: Central Walvis Ridge, main southern edifice, lower southern slope. Irregular slope.

Dredge on bottom UTC 06/06/14 21:41hrs, lat 26°23.26'S, long 6°29.71'E, depth 3216m
Dredge off bottom UTC 06/06/14 22:32hrs, lat 26°23.25'S, long 6°30.04'E, depth 3012m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 59: Central Walvis Ridge edivice, Northwest corner of plateau

Dredge on bottom UTC 07/06/14 01:27hrs, lat 26°28.42'S, long 6°27.56'E, depth 3530m
Dredge off bottom UTC 07/06/14 02:48hrs, lat 26°28.51'S, long 6°28.16'E, depth 3085m
total volume: 2 rocks
Comments: basalt and biogenic carbonate
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 60: Central Walvis Ridge, main southern edifice, upper southern slope.
Dredge on bottom UTC 07/06/14 06:02hrs, lat 26°20.82'S, long 6°24.56'E, depth 2528m
Dredge off bottom UTC 07/06/14 07:10hrs, lat 26°20.82'S, long 6°24.93'E, depth 2226m
total volume: 2 rocks
Comments: volcanic
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 61: Central Walvis Rdge, eastern plateau edge, deep canyon.
Dredge on bottom UTC 07/06/14 13:46hrs, lat 25°52.43'S, long 6°36.50'E, depth 3736m
Dredge off bottom UTC 07/06/14 15:57hrs, lat 25°52.50'S, long 6°36.58'E, depth 3684m
total volume: empty
Comments: bridge took over at 3600m rope length
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 62: Central Walvis Ridge, eastern margin, lower part of deep canyon. Valley in canyon.
Dredge on bottom UTC 07/06/14 19:24hrs, lat 25°51.05'S, long 6°36.33'E, depth 3765m
Dredge off bottom UTC 07/06/14 20:49hrs, lat 25°51.01'S, long 6°36.81'E, depth 3318m
total volume: 2 rocks
Comments: fresh basalt and volcaniclastica with glass particles
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 63: Central Walvis Ridge, eastern slope. Repetition of Dredge haul DR61 but only the uppermost part.
Dredge on bottom UTC 07/06/14 23:30hrs, lat 25°52.59'S, long 6°36.54'E, depth 3400m
Dredge off bottom UTC 08/06/14 00:27hrs, lat 25°52.77'S, long 6°36.64'E, depth 3106m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 64: Central Walvis Ridge, eastern deep flank. Southern wall of little slope canyon.
Dredge on bottom UTC 08/06/14 06:40hrs, lat 25°21.79'S, long 6°43.26'E, depth 2930m
Dredge off bottom UTC 08/06/14 08:06hrs, lat 25°21.90'S, long 6°43.20'E, depth 2720m
total volume: four rocks
Comments: volcanic rocks; bridge took over at 2724m rope length
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - TVMUC 65: Northern part of Walvis Ridge, east side ~100nm north of DR64
TV-MUC on bottom UTC 08/06/14 17:55hrs, lat 23°55.81'S, long 6°45.32'E, depth 2861m
TV-MUC off bottom UTC 08/06/14 17:57hrs, lat 23°55.80'S, long 6°45.32'E, depth 2861m
total volume: 3 tubes with sediment (~10 cm)
Comments: Water analyses O_2 40.6 % , pH 7.81 and salt content 3.39 %
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	5							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna												

SO233 - DR 66: Central Walvis Ridge, eastern side. Ridge-like structure, western slope.
Dredge on bottom UTC 09/06/14 11:53hrs, lat 22°42.66'S, long 7°34.25'E, depth 3871m
Dredge off bottom UTC 09/06/14 13:04hrs, lat 22°42.90'S, long 7°34.62'E, depth 3551m
total volume: few rocks
Comments: volcanics and pyroclastic sediment
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 67: Central Walvis Ridge, Eastern Part. Northern slope of a guyot.
Dredge on bottom UTC 10/06/14 08:36hrs, lat 22°22.05'S, long 7°30.13'E, depth 2235m
Dredge off bottom UTC 10/06/14 --:--hrs, lat --°--.--'S, long --°--.--'E, depth ----m
total volume:
Comments: Dredge and 400m rope lost at 13:20hrs by 13.5t rope tension
gDR

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna												
Macrofauna												

SO233 - DR 68: Central Walvis Ridge, north-eastern side, northern slope of a guyot.
Dredge on bottom UTC 11/06/14 14:03hrs, lat 22°27.57'S, long 6°50.26'E, depth 2408m
Dredge off bottom UTC 11/06/14 15:13hrs, lat 22°28.02'S, long 6°50.33'E, depth 2105m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 69: Central walvis Ridge, NE side. Same structure as DR68 but 1 nm to the SW, western slope.
Dredge on bottom UTC 11/06/14 17:18hrs, lat 22°28.21'S, long 6°48.95'E, depth 2246m
Dredge off bottom UTC 11/06/14 18:24hrs, lat 22°28.59'S, long 6°49.14'E, depth 1946m
total volume: few rocks
Comments: carbonate crusts
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	2	x								EtOH	
	Porifera	2	x								EtOH	2 different species
	Hexacorallia	4	x								EtOH	3 species, one *Fungiacyathus hydra* ?
	Bryozoa	1	x								EtOH	ctenostome
	Brachiopoda	1	x								EtOH	*Eucalathis*

SO233 - DR 70: Same location as DR68.
Dredge on bottom UTC 11/06/14 21:10hrs, lat 22°27.68'S, long 6°50.20'E, depth 2589m
Dredge off bottom UTC 11/06/14 22:34hrs, lat 22°28.13'S, long 6°50.31'E, depth 1944m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 71: Central Walvis Ridge, north-western side at the western slope of a guyot.
Dredge on bottom UTC 12/06/14 09:44hrs, lat 22°39.80'S, long 5°07.30'E, depth 3115m
Dredge off bottom UTC 12/06/14 11:22hrs, lat 22°39.90'S, long 5°07.43'E, depth 2979m
total volume: 2 rocks
Comments: one volcaniclastic sediment and one volcanic rock, both highly altered
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 72: Central Walvis Ridge, north-western side at the western slope of a guyot, few nm north of DR71.
Dredge on bottom UTC 12/06/14 15:16hrs, lat 22°36.90'S, long 5°07.00'E, depth 3020m
Dredge off bottom UTC 12/06/14 16:37hrs, lat 22°37.20'S, long 5°07.37'E, depth 2687m
total volume: 1 rock
Comments: one volcaniclastic sediment
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Tunicata	6					x				EtOH	*Cyclosalpa* aggregates, from surface plankton
	Tunicata	>10						x			F	*Cyclosalpa* and another species
	Tunicata	5			x						Bouin	*Cyclosalpa* and another species
	Tunicata	4			x						Glu	*Cyclosalpa* aggregates
	Tunicata	3			x						PFA	*Cyclosalpa* aggregates
	Tunicata	>20							x		F	*Cyclosalpa* aggregates

SO233 - DR 73: Northern Walvis Ridge, western slope of main plateau. Slope of N-S trending ridge.
Dredge on bottom UTC 12/06/14 20:47hrs, lat 22°25.65'S, long 5°06.21'E, depth 3350m
Dredge off bottom UTC 12/06/14 21:54hrs, lat 22°25.87'S, long 5°06.55'E, depth 3074m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 74: Northern Walvis Ridge, western slope of main plateau. Base of slope.
Dredge on bottom UTC 13/06/14 02:39hrs, lat 22°13.92'S, long 5°03.31'E, depth 3801m
Dredge off bottom UTC 13/06/14 03:28hrs, lat 22°14.16'S, long 5°03.32'E, depth 3584m
total volume: one rock
Comments: highly altered volcanic rock
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 75: Central Walvis Ridge, north-western side in a steep canyon (south-eastern slope).
Dredge on bottom UTC 13/06/14 09:36hrs, lat 22°04.48'S, long 5°06.09'E, depth 4106m
Dredge off bottom UTC 13/06/14 10:56hrs, lat 22°04.79'S, long 5°06.19'E, depth 3578m
total volume: less than half full
Comments: volcanic rocks
gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	2	x								EtOH	2 species
	Porifera	2	x								EtOH	2 species
	Cnidaria	>5						x			F	pieces of isidid and other octocorals
	Cnidaria	>5					x				EtOH	pieces of isidid and other octocorals
	Bryozoa	3	x								EtOH	2 species

SO233 - TVMUC 76: Northern part of Walvis Ridge, between ridge and northern seamount
TV-MUC on bottom UTC 13/06/14 16:28hrs, lat 21°35.99'S, long 5°01.32'E, depth 4463m
TV-MUC off bottom UTC 13/06/14 16:30hrs, lat 21°35.99'S, long 5°01.32'E, depth 4463m
total volume: 2 tubes with sediment
Comments: Water analyses O_2 40.5 % , pH 7.8 and salt content 3.34 %
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	3							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna												

SO233 - DR 77: Northern Walvis Ridge, western one of the two isolated seamounts. Parallel to southern slope.
Dredge on bottom UTC 14/06/14 01:13hrs, lat 21°12.93'S, long 5°04.13'E, depth 3273m
Dredge off bottom UTC 14/06/14 02:33hrs, lat 21°12.90'S, long 5°03.63'E, depth 2972m
total volume: three rocks
Comments: volcanic rocks (pillow lava)
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - TVG 78: Northern Walvis Ridge, second northern seamount, NE of the first one

TVG on bottom UTC 14/06/14 12:13hrs, lat 20°09.45'S, long 5°59.07'E, depth 2152 / 2157m
TVG off bottom UTC 14/06/14 13:58hrs, lat 20°10.19'S, long 5°59.09'E, depth 2163 / 2147m
total volume: empty
Comments: 3x failed to grab sediment or rocks, battery empty

TVG

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna												
Macrofauna												

SO233 - TVG 79: Northern Walvis Ridge, second northern seamount. Repeat of TVG78, same position as end of TVG78.

Dredge on bottom UTC 14/06/14 15:40hrs, lat 20°10.19'S, long 5°59.09'E, depth 2160m
Dredge off bottom UTC 14/06/14 15:47hrs, lat 20°10.19'S, long 5°59.09'E, depth 2173m
total volume: some benthos, no sediment or rock
Comments: corals, echinoderms, crustaceans, molluscs

gDR, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Macrofauna	Cnidaria	1				x					EtOH	Actiniaria on octocoral stem
	Cnidaria	>5					x				EtOH	Octocoral stemms with actinians and cirripeds
	Cnidaria	2					x				EtOH	2 pieces of octocoral
	Cnidaria	>5								x	dry	twigs of octocoral and *Corallium*
	Gastropoda	2				x					EtOH	
	Crustacea	10				x					EtOH	Cirripedia
	Crustacea	1								x	dry	1 piece of large cirriped "shell"
	Crinoidea	2						x			F	2 species, 1 large, yellow; 1 small, brownish
	Crinoidea	5						x			F	plus 1 ophiuroid and 2 pieces of octocoral
	Crinoidea	1									EtOH	large, neon yellow
	Crinoidea	1									EtOH	small, light brown
	Crinoidea	2				x					EtOH	two arms of yellow species
	Crinoidea	2				x					EtOH	light brown species
	Crinoidea	1				x					EtOH	juvenile yellow crinoid
	Crinoidea	2			x						PFA	two arms of yellow species
	Crinoidea	2			x						Glu	two arms of yellow species
	Crinoidea	2			x						PFA	two arms of light brown species
	Crinoidea	2			x						Glu	two arms of light brown species
	Ophiuroidea	1				x					EtOH	pinkish arms
	Ophiuroidea	>5				x					EtOH	pinkish arms
	Ophiuroidea	3			x						PFA	
	Ophiuroidea	2			x						Glu	
	Ophiuroidea	1	x								PFA	arm of 1 specimen
	Ophiuroidea	1	x								Glu	arm of 1 specimen
	mixed pickles									2L	F	all remains of octocorals and associated fauna
	?small fluffy something	1			x						EtOH	fixed to octocoral twig

SO233 - DR 80: Northern Walvis Ridge, seamount at the northernmost part of the Walvis Ridge basement.

Dredge on bottom UTC 14/06/14 19:20hrs, lat 20°12.70'S, long 5°55.53'E, depth 3608m
Dredge off bottom UTC 14/06/14 20:40hrs, lat 20°13.15'S, long 5°55.56'E, depth 3200m
total volume: four rocks
Comments: volcanic rocks

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Cnidaria	1				x					EtOH	piece of isidid coral
	Cnidaria	4						x			F	pieces of isidid coral
	Polychaeta	1	x								EtOH	

SO233 - TV-MUC 81: Northern part of Walvis Ridge, north-western side

TV-MUC on bottom UTC 15/06/14 06:11hrs, lat 20°26.92'S, long 7°11.73'E, depth 4346m
TV-MUC off bottom UTC 15/06/14 06:13hrs, lat 20°26.92'S, long 7°11.73'E, depth 4345m
total volume: 6 tubes with sediment (~10 cm)
Comments: Water analyses O_2 40.3 % , pH 7.78 and salt content 3.33 %

TV-MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	11							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna												

SO233 - DR 82: Northern part of Walvis Ridge. Deep slope at the northern boundary.
Dredge on bottom UTC 15/06/14 11:47hrs, lat 20°29.10'S, long 7°20.32'E, depth 4213m
Dredge off bottom UTC 15/06/14 13:07hrs, lat 20°29.55'S, long 7°20.36'E, depth 3720m
total volume: less than half full
Comments: unconsolidated to slightly consolidated sediments
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 83: Northern part of Walvis Ridge. Deep slope at the northern boundary. Few nm northeast of DR82
Dredge on bottom UTC 15/06/14 17:52hrs, lat 20°23.51'S, long 7°28.25'E, depth 4531m
Dredge off bottom UTC 15/06/14 19:12hrs, lat 20°23.87'S, long 7°28.34'E, depth 4000m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 84: Northern Walvis Ridge, northwestern slope. Upper slope.
Dredge on bottom UTC 16/06/14 01:04hrs, lat 20°20.37'S, long 7°38.12'E, depth 3794m
Dredge off bottom UTC 16/06/14 02:12hrs, lat 20°20.62'S, long 7°38.38'E, depth 3409m
total volume: few rocks
Comments: volcanic rocks, consolidated sediment, chert in sediment
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - DR 85: Northern Walvis Ridge, same location as DR84, but few nm northeast and deeper.
Dredge on bottom UTC 16/06/14 07:32hrs, lat 20°17.50'S, long 7°44.06'E, depth 4150m
Dredge off bottom UTC 16/06/14 08:45hrs, lat 20°17.57'S, long 7°44.44'E, depth 3714m
total volume: empty
Comments:
gDR, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna												

SO233 - TVG 86: Central Walvis Ridge, eastern side. Ridge-like structure, western slope.
TVG on bottom UTC 16/06/14 16:52hrs, lat 20°42.24'S, long 8°41.11'E, depth 354m
TVG off bottom UTC 16/06/14 17:15hrs, lat 20°47.24'S, long 8°41.13'E, depth 345m
total volume: full
Comments:
TVG, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	4							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Porifera	>10			x						EtOH	several species
	Porifera	1	x								EtOH	
	Porifera	2	x								EtOH	two species
	Porifera	3	x								EtOH	
	Porifera	4	x								EtOH	three species
	Porifera	2	x								EtOH	purple
	Porifera	1	x								EtOH	
	Porifera	4	x								EtOH	several species
	Porifera	2	x								EtOH	cone-shaped with central appendix
	Porifera	2	x								EtOH	
	Porifera	2	x								EtOH	
	Cnidaria	1	x								EtOH	soft coral stem, brownish
	Cnidaria	3	x								EtOH	soft corals, probably two species
	Cnidaria	1	x								EtOH	soft coral stem, brownish, same as above
	Cnidaria	2	x								EtOH	very delicate hydrozoans
	Cnidaria	1	x								EtOH	warty hydrozoan polyp, pinkish
	Cnidaria	1	x								EtOH	single, large (+5 cm) caryophylliid hexacoral
	Bivalvia	>20	x								EtOH	small, brownish, all the same
	Bivalvia	2	x								EtOH	same as above
	Polyplacophora	1	x								EtOH	
	Polychaeta	>5	x								EtOH	polynoid scale worms, "hairy", curled in alc.
	Polychaeta	2	x								EtOH	

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
	Polychaeta	3	x								EtOH	large polynoids with extracted pharynx
	Polychaeta	1	x								EtOH	terebellid, from long strongly cemented tubes made of shelly particles
	Polychaeta	>5	x								EtOH	polynoid scale worms, "hairy", curled in alc.
	Polychaeta	1	x								EtOH	red, small
	Polychaeta	2	x								EtOH	small opheliid? No obvious bristles
	Polychaeta	1	x								EtOH	terebellid, same as above
	Polychaeta	1	x								EtOH	small opheliid? No obvious bristles
	Polychaeta	2	x								EtOH	terebellid + large polynoid living in one tube
	Polychaeta	2		x							EtOH	terebellid + large polynoid living in one tube
	Polychaeta	1		x							EtOH	terebellid, same as above
	Polychaeta	1		x							EtOH	terebellid, same as above
	Polychaeta	1	x								EtOH	small terebellid in tube
	Polychaeta	1	x								EtOH	large polynoid
	Polychaeta	>5	x								EtOH	polynoid scale worms, "hairy", curled in alc.
	Polychaeta	1	x								EtOH	small, lumbricid like
	Polychaeta	1	x								EtOH	terebellid
	Polychaeta	1	x								EtOH	
	Polychaeta	1	x								EtOH	terebellid
	Polychaeta											
	Crustacea	4	x								EtOH	Amphipoda
	Crustacea	>30	x								EtOH	Caprellidae
	Crustacea	1	x								EtOH	Tanaidacea
	Crustacea	2	x								EtOH	Isopoda
	Crustacea	1	x								EtOH	Amphipoda
	Crustacea	1	x								EtOH	Amphipoda
	Crustacea	4	x								EtOH	Tanaidacea, with greenish, branched tubes
	Crustacea	>30	x								EtOH	Caprellidae
	Crustacea	1	x								EtOH	Munidae, juvenile
	Crustacea	3	x								EtOH	Isopoda, possibly two are Tanaidacea
	Crustacea	2	x								EtOH	Amphipoda,very long legs, small body
	Crustacea	1	x								EtOH	Tanaidacea, branched tube with animals inside
	Pantopoda	1	x								EtOH	*Nymphon* -like
	Pantopoda	1	x								EtOH	smaller, different eye stalk
	Bryozoa	~5	x								EtOH	branched ctenostomes on worm tubes
	Bryozoa	~5	x								EtOH	branched ctenostomes on worm tubes
	Brachiopoda	8	x								EtOH	*Eucalathis*
	Brachiopoda	2	x								EtOH	*Eucalathis*
	Ophiuroidea	1	x								EtOH	pinkish arms
	Ophiuroidea	2	x								EtOH	same as above
	Asteroidea	1	x								EtOH	1 arm of a 5 cm large specimen
	Asteroidea	1	x								F	main part of the same specimen
	Asteroidea	1	x								Glu	arm tip of the same specimen
	Asteroidea	1	x								PFA	arm tip of the same specimen
	"Pisces"	>5	x								EtOH	fish larvae, still in egg shells separately sticking to substrate
	Mixed pickles							x			F	a good cross section of the fauna above

SO233 - DR 87: Northern Walvis Ridge, large shallow flat-topped seamount. Northern slope.

Dredge on bottom UTC 16/06/14 21:57hrs, lat 20°38.61'S, long 8°37.69'E, depth 1848m

Dredge off bottom UTC 16/06/14 23:25hrs, lat 20°39.01'S, long 8°37.93'E, depth 1330m

total volume: more than half full

Comments: volcanic rocks, breccia, Mn crusts, sediments, biology

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	>5			x						EtOH	different species
	Porifera	1	x								EtOH	
	Porifera	~10	x								EtOH	different species
	Porifera	1	x								EtOH	
	Porifera	1	x								EtOH	like a furry ball, yellow
	Porifera	1	x								EtOH	hexactinellid?
	Cnidaria	3	x								EtOH	Coronata
	Cnidaria	>10	x								EtOH	Caryophylliidae, dead skeletons
	Cnidaria	1	x								EtOH	Ceriantharia?
	Cnidaria	>10				x					EtOH	twigs of very delicate black coral
	Cnidaria	1								2L	F	large piece of delicate black coral
	Cnidaria	1						x			F	pieces of delicate black coral
	Cnidaria	2								x	dry	two thick stems of octocorals, 3 old caryophylliids
	Polychaeta	2	x								EtOH	2 species
	Polychaeta	5	x								EtOH	different species
	Polyplacophora	1	x								EtOH	
	Aplacophora	1	x								EtOH	neomeniid worm mollusc
	Bivalvia	2	x								EtOH	*Arca* sp.
	Cirripedia	5	x								EtOH	partly destroyed

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
	Amphipoda	3	x								EtOH	
	Bryozoa	>5	x								EtOH	ctenostomes and one cheilostome colony
	Brachiopoda	4	x								EtOH	rhynchonellids, possibly *Leptothyrella*
	Brachiopoda	>10	x								EtOH	*Novocrania* sp.
	Brachiopoda	1	x								EtOH	terebratulid, juv. *Stenosarina* ?
	Ophiuroidea	1	x								EtOH	one arm and part of disc in PFA
	Ophiuroidea	1	x								PFA	one arm from specimen above
	Holothuroidea	1	x								EtOH	very small, two frontal tentacles
	Tunicata	1	x								EtOH	sessile flat ascidian

SO233 - TV-MUC 88: Northern Walvis Ridge, abyssal plain SE of large seamount

TV-MUC on bottom UTC 17/06/14 05:52hrs, lat 20°59.29'S, long 9°12.59'E, depth 3856m

TV-MUC off bottom UTC 17/06/14 05:54hrs, lat 20°59.29'S, long 9°12.59'E, depth 3856m

total volume: 7 tubes with sediment

Comments: water analyses O2 38.8 % , pH 7.80 and salt content 3.38 %

TV-MUC, sediment

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	13							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna												

SO233 - DR 89: Northern part of Walvis Ridge, northeastern section, northwestern margin. Upper northwestern slope of a large guyot situated on the margin of the ridge.

Dredge on bottom UTC 17/06/14 18:49hrs, lat 19°17.25'S, long 9°57.21'E, depth 2004m

Dredge off bottom UTC 17/06/14 20:07hrs, lat 19°17.55'S, long 9°57.41'E, depth 1619m

total volume: 10 rocks, biology

Comments: volcanic rocks (lava flow) and breccia (volcaniclastic)

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	3	x								EtOH	
	Porifera	3	x								EtOH	2-3 species
	Porifera	1				x					EtOH	piece of large, globular sponge, 15 cm diameter
	Porifera	1				x					EtOH	piece of large lithistid sponge
	Porifera	1				x					EtOH	piece of large lithistid sponge
	Porifera	1				x					EtOH	piece of large lithistid sponge
	Porifera	>5								10L	F	lithistid and other sponges, large specimens
	Cnidaria	1		x							EtOH	twig of octocoral stem
	Cnidaria	>5	x								EtOH	Alcyonaria
	Cnidaria	3								x	dry	Large pieces of octocorals, substrate for brachs
	Polychaeta	2	x								EtOH	Sabellids
	Polychaeta	1	x								EtOH	
	Polyplacophora	1			x						EtOH	large specimen ~2.5 cm, long frontal mantle rim
	Bryozoa	3	x								EtOH	branched ctenostomes
	Brachiopoda	~20	x								EtOH	*Platidia*
	Brachiopoda	>10	x								EtOH	*Novocrania*
	Brachiopoda	~10	x								EtOH	*Platidia*
	Brachiopoda	1	x								EtOH	crushed, lophophore like *Eucalathis* , but shell diff.
	Brachiopoda	1	x								EtOH	*Platidia* with brooded 3-l-s larvae!!! Glass vial.
	Asteroidea	1						x			F	*Astropecten?*

SO233 - DR 90: Northern part of Walvis Ridge, northeastern section, northwestern margin.
Small "noose" at upper slope of a seamount off the northeastern termination of the margin at the base of the continental slope.

Dredge on bottom UTC 18/06/14 09:33hrs, lat 18°25.84'S, long 10°52.99'E, depth 2539m

Dredge off bottom UTC 18/06/14 10:38hrs, lat 18°25.95'S, long 10°53.31'E, depth 1619m

total volume: few rocks

Comments:

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	1							x		F	from sediment traps
Macrofauna	Porifera	1							x		F	soft, large with undulating margin
	Porifera	1				x					EtOH	piece of the large sponge above
	Porifera	4	x								EtOH	
	Polychaeta	1	x								EtOH	terebellid
	Polychaeta	2	x								EtOH	
	Brachiopoda	2	x								EtOH	small terebratulid
	Brachiopoda	2	x								EtOH	*Eucalathis* pedicles?
	Brachiopoda	3	x								EtOH	*Novocrania*
	Brachiopoda	3	x								EtOH	*Eucalathis,* large specimens
	Brachiopoda	5	x								EtOH	*Platidia*
	Brachiopoda	1	x								EtOH	*Eucalathis*

SO233 - TV-MUC 91: Northern Walvis Ridge, shelf E of DR 90

TVMUC on bottom UTC 18/06/14 16:02hrs, lat 18°18.04'S, long 11°25.78'E, depth 421m

TVMUC off bottom UTC 18/06/14 16:04hrs, lat 18°18.04'S, long 11°25.78'E, depth 421m

total volume: 7 tubes with dark green volcanic sediment with many worm tubes,

Comments: water analyses O2 13.7 % , pH 7.67 and salt content 3.39 %

gDR, sediment, macrofauna

	TAXA	n	2	5	50	100	200	500	1000	other	FIX	NOTES
Meiofauna	unsorted	13							x		F	500ml sediment per Kautex jar, 1 PD (TOC, TC)
Macrofauna	Polychaeta	2				x					EtOH	

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GEOMAR Reports

No.	Title
1	FS POSEIDON Fahrtbericht / Cruise Report POS421, 08. – 18.11.2011, Kiel - Las Palmas, Ed.: T.J. Müller, 26 pp, DOI: 10.3289/GEOMAR_REP_NS_1_2012
2	Nitrous Oxide Time Series Measurements off Peru – A Collaboration between SFB 754 and IMARPE –, Annual Report 2011, Eds.: Baustian, T., M. Graco, H.W. Bange, G. Flores, J. Ledesma, M. Sarmiento, V. Leon, C. Robles, O. Moron, 20 pp, DOI: 10.3289/GEOMAR_REP_NS_2_2012
3	FS POSEIDON Fahrtbericht / Cruise Report POS427 – Fluid emissions from mud volcanoes, cold seeps and fluid circulation at the Don-_Kuban deep sea fan (Kerch peninsula, Crimea, Black Sea) – 23.02. – 19.03.2012, Burgas, Bulgaria - Heraklion, Greece, Ed.: J. Bialas, 32 pp, DOI: 10.3289/GEOMAR_REP_NS_3_2012
4	RV CELTIC EXPLORER EUROFLEETS Cruise Report, CE12010 – ECO2@NorthSea, 20.07. – 06.08.2012, Bremerhaven – Hamburg, Eds.: P. Linke et al., 65 pp, DOI: 10.3289/GEOMAR_REP_NS_4_2012
5	RV PELAGIA Fahrtbericht / Cruise Report 64PE350/64PE351 – JEDDAH-TRANSECT -, 08.03. – 05.04.2012, Jeddah – Jeddah, 06.04 - 22.04.2012, Jeddah – Duba, Eds.: M. Schmidt, R. Al-Farawati, A. Al-Aidaroos, B. Kürten and the shipboard scientific party, 154 pp, DOI: 10.3289/GEOMAR_REP_NS_5_2013
6	RV SONNE Fahrtbericht / Cruise Report SO225 - MANIHIKI II Leg 2 The Manihiki Plateau - Origin, Structure and Effects of Oceanic Plateaus and Pleistocene Dynamic of the West Pacific Warm Water Pool, 19.11.2012 - 06.01.2013 Suva / Fiji – Auckland / New Zealand, Eds.: R. Werner, D. Nürnberg, and F. Hauff and the shipboard scientific party, 176 pp, DOI: 10.3289/GEOMAR_REP_NS_6_2013
7	RV SONNE Fahrtbericht / Cruise Report SO226 – CHRIMP CHatham RIse Methane Pockmarks, 07.01. - 06.02.2013 / Auckland – Lyttleton & 07.02. – 01.03.2013 / Lyttleton – Wellington, Eds.: Jörg Bialas / Ingo Klaucke / Jasmin Mögeltönder, 126 pp, DOI: 10.3289/GEOMAR_REP_NS_7_2013
8	The SUGAR Toolbox - A library of numerical algorithms and data for modelling of gas hydrate systems and marine environments, Eds.: Elke Kossel, Nikolaus Bigalke, Elena Piñero, Matthias Haeckel, 168 pp, DOI: 10.3289/GEOMAR_REP_NS_8_2013
9	RV ALKOR Fahrtbericht / Cruise Report AL412, 22.03.-08.04.2013, Kiel – Kiel. Eds: Peter Linke and the shipboard scientific party, 38 pp, DOI: 10.3289/GEOMAR_REP_NS_9_2013
10	Literaturrecherche, Aus- und Bewertung der Datenbasis zur Meerforelle (*Salmo trutta trutta L.*) Grundlage für ein Projekt zur Optimierung des Meerforellenmanagements in Schleswig-Holstein. Eds.: Christoph Petereit, Thorsten Reusch, Jan Dierking, Albrecht Hahn, 158 pp, DOI: 10.3289/GEOMAR_REP_NS_10_2013
11	RV SONNE Fahrtbericht / Cruise Report SO227 TAIFLUX, 02.04. – 02.05.2013, Kaohsiung – Kaohsiung (Taiwan), Christian Berndt, 105 pp, DOI: 10.3289/GEOMAR_REP_NS_11_2013

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12	RV SONNE Fahrtbericht / Cruise Report SO218 SHIVA (Stratospheric Ozone: Halogens in a Varying Atmosphere), 15.-29.11.2011, Singapore - Manila, Philippines, Part 1: SO218- SHIVA Summary Report (in German), Part 2: SO218- SHIVA English reports of participating groups, Eds.: Birgit Quack & Kirstin Krüger, 119 pp, DOI: 10.3289/GEOMAR_REP_NS_12_2013
13	KIEL276 Time Series Data from Moored Current Meters. Madeira Abyssal Plain, 33°N, 22°W, 5285 m water depth, March 1980 – April 2011. Background Information and Data Compilation. Eds.: Thomas J. Müller and Joanna J. Waniek, 239 pp, DOI: 10.3289/GEOMAR_REP_NS_13_2013
14	RV POSEIDON Fahrtbericht / Cruise Report POS457: ICELAND HAZARDS Volcanic Risks from Iceland and Climate Change:The Late Quaternary to Anthropogene Development Reykjavík / Iceland – Galway / Ireland, 7.-22. August 2013. Eds.: Reinhard Werner, Dirk Nürnberg and the shipboard scientific party, 88 pp, DOI: 10.3289/GEOMAR_REP_NS_14_2014
15	RV MARIA S. MERIAN Fahrtbericht / Cruise Report MSM-34 / 1 & 2, SUGAR Site, Varna – Varna, 06.12.13 – 16.01.14. Eds: Jörg Bialas, Ingo Klaucke, Matthias Haeckel, 111 pp, DOI: 10.3289/GEOMAR_REP_NS_15_2014
16	RV POSEIDON Fahrtbericht / Cruise Report POS 442, "AUVinTYS" High-resolution geological investigations of hydrothermal sites in the Tyrrhenian Sea using the AUV "Abyss", 31.10. – 09.11.12, Messina – Messina, Ed.: Sven Petersen, 32 pp, DOI: 10.3289/GEOMAR_REP_NS_16_2014
17	RV SONNE, Fahrtbericht / Cruise Report, SO 234/1, "SPACES": Science or the Assessment of Complex Earth System Processes, 22.06. – 06.07.2014, Walvis Bay / Namibia - Durban / South Africa, Eds.: Reinhard Werner and Hans-Joachim Wagner and the shipbord scientific party, 44 pp, DOI: 10.3289/GEOMAR_REP_NS_17_2014
18	RV POSEIDON Fahrtbericht / Cruise Report POS 453 & 458, "COMM3D", Crustal Structure and Ocean Mixing observed with 3D Seismic Measurements, 20.05. – 12.06.2013 (POS453), Galway, Ireland – Vigo, Portugal, 24.09. – 17.10.2013 (POS458), Vigo, Portugal – Vigo, Portugal, Eds.: Cord Papenberg and Dirk Klaeschen, 66 pp, DOI: 10.3289/GEOMAR_REP_NS_18_2014
19	RV POSEIDON, Fahrtbericht / Cruise Report, POS469, "PANAREA", 02. – 22.05.2014, (Bari, Italy – Malaga, Spain) & Panarea shallow-water diving campaign, 10. – 19.05.2014, Ed.: Peter Linke, 55 pp, DOI: 10.3289/GEOMAR_REP_NS_19_2014
20	RV SONNE Fahrtbericht / Cruise Report SO234-2, 08.-20.07.2014, Durban, South Africa - Port Louis, Mauritius, Eds.: Kirstin Krüger, Birgit Quack and Christa Marandino, 95 pp, DOI: 10.3289/GEOMAR_REP_NS_20_2014
21	RV SONNE Fahrtbericht / Cruise Report SO235, 23.07.-07.08.2014, Port Louis, Mauritius to Malé, Maldives, Eds.: Kirstin Krüger, Birgit Quack and Christa Marandino, 76 pp, DOI: 10.3289/GEOMAR_REP_NS_21_2014

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